THE

ELECTRICAL REVIEW.

VOL. XXX. JANUARY 29, 1892. No. 740

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LABOUR QUESTIONS AND ARBITRATION.

THE London Chamber of Commerce has been the means of a large amount of good work being done not only in the metropolis, but also by force of example in the provinces during the past few years. It has, among other important matters, effected the formation in connection with the Chamber of different trade sections. The members in each of these have been brought in closer together, and by the discussion of trade subjects, they have generally been enabled to act in a combined manner for the furtherence of the object in view. This fact has prevailed to a certain extent with the Electrical Trades Section. It is, however, particularly to disputes between employers and *employés*, and to the part which the London Chamber of Commerce is taking in the matter, that we wish to refer.

It was with a view to adjust disputes between workmen and masters, and to prevent strikes and lock-outs, that the Chamber of Commerce established some two years ago a committee whose object was to form a Board of Conciliation, and pending the constitution of the latter, to settle any differences brought before it. The Board was completely constructed at the end of 1890, when the functions of the organising committee ceased. It would be difficult, considering the short lapse of time, to disassociate the operations of the two bodies, as in some instances the negotiations conducted between employers and workmen have been continuous. With the close of last year terminated the first twelve months' work of the Board, whose report for that period now lies before us. In looking over this, the only conclusion to be drawn is that the Board has been successful in the objects it had in view; not that disputes were amicably settled in every case, but that the majority of those mentioned in the report appear to have been adjusted satisfactorily. According to the original scheme, the Board intervened only when asked to do so; now it takes the first steps, and proffers assistance to both parties before disputes reach a critical stage.

Special conciliation committees for various trades associated with the Board have been formed, one being for the engineering branches, and at present 60 trade unions are connected with the Board. An important feature is the fact that similar movements are developing in the provinces. The Association of Chambers of Commerce of the United Kingdom, at its last meeting, unanimously recommended the establishment of boards of conciliation for labour disputes in different localities, and since then no less than 24 Chambers of Commerce have taken, or are taking, action to found such boards.

It will be evident that the work of the London Board of Conciliation has borne good fruit, and the movement seems to be gradually progressing. There appears to be no valid

objection to raise against such organisations which, by bringing together both employers and those employed, promote a better feeling between the two. With the exception of the great Silvertown strike, and the one at Latimer Clark, Muirhead and Co., the electrical industry has fortunately, been practically free from labour disputes, and it is to be hoped that it may long continue to be so. The industry is, however, growing, and trouble *may* arise, as has been the case in other progressive trades. A conciliation board would then doubtless prove of great utility.

EXHIBITIONS.

IT is but natural that very diverse views should exist as to the benefits to be derived from exhibitions, and that these views should find expression in connection with the show now being held at the Crystal Palace.

It would be interesting if we could know how the future historian will deal with an institution which is peculiar to the nineteenth century. Commencing with the second half of the century, we have had International, General and Special Exhibitions of all kinds. Bazaars and marts are old enough, but an exhibition, though allied to both, is neither the one nor the other, and no preceding institution will be found to exactly compare with it. The historian will probably come to the conclusion that the institution existed in the latter half of the nineteenth century, because it was one suited to the requirements of the period.

The exhibition now in progress at the Crystal Palace is a good representative of the industrial class. The subjects appeal to the imagination and the interest of the public in a way that few other industrial subjects could. The exhibition is held in a building to which the public are accustomed to go for amusement, and which has some attractions in itself, so that whether a visitor's primary aim be amusement or information, there is the possibility of combining both.

In common with many others, we were by no means sanguine that the invitation of the directors of the Crystal Palace Company would be responded to by the electrical trades in a way to ensure the Exhibition being a success. It must be generally admitted that any fears which may have existed on that account are set at rest.

The exhibits, on the whole, are arranged in a very creditable manner. Individually, they are, with very few exceptions, prepossessing. A critic of styles would probably find most of the exhibits reflect some of the characteristics, and even methods of business, of the exhibitors. Collectively, the exhibits are attractive. There seems to have been an appreciation of a sort of reasonable bargain between the Crystal Palace Company and the exhibitors. On the one hand is given a floor and a roof, with surroundings such as the public have become accustomed to expect and therefore to demand. On the other hand the space at disposal has been covered with attractive buildings and interesting exhibits, and the roof has been utilised for the suspension of shining lights appropriate to the occasion. As individualism has been allowed full scope it is surprising that the general effect has no seriously discordant element, but that all blend with fair harmony.

That the exhibition is timely must be generally admitted. The decade which has elapsed since the previous exhibition at the Crystal Palace has been fruitful in new devices, in a settling down to solid work, and a shaking off of unhealthy attributes, to which without doubt it largely contributed. This last point is one which should be well borne in mind, and all interested in electrical matters should see to it, that the present exhibition is not taken advantage of by schemers of any sort. It is to be hoped that exhibitors will confine themselves to reaping legitimate rewards. The opportunity the exhibition offers may be simply stated. It enables those who have availed themselves of it to take their show rooms to a larger section of the public than would be likely to betake themselves to the show rooms, and it will create demands which will extend to the trade generally. Probably no exhibition was ever held which did not reveal to an interested visitor something of whose existence he was ignorant, or which did not afford him some information of value.

Exhibitions held too frequently, or those which make the business element too prominent, defeat their own objects. The first requirement for the success of exhibitors is that the exhibition shall itself be a success. There is now a universal agreement that the Crystal Palace Exhibition is a success, and we are inclined to believe that the exhibitors should also find it tend to their advantage.

An "Echo of Science."

THE ("newspaper" ?) scientist who is responsible for the first paragraph on page 6 of last Friday's *Globe*, should promptly be offered a position on the editorial staff of *Science Siftings*: he is surely not finding sufficient scope for his energy of imagination in a weekly column of "Echoes of Science." Here is the "par.," which is truly a delightful sample of what the newspaper man can do when he tries:—"The telegram to the effect that Edison is working at a new invention for enabling soldiers in a fort to destroy an attacking force by a jet of electrified water is very brief; but it is possible to divine the underlying method. If we suppose the water to be contained in an insulated reservoir, and connected to one pole of the dynamo, or source of electricity, while the other pole is connected to the ground, it follows that if the enemy in marching over the ground be struck by a continuous jet of the electrified water the circuit will be completed, and they will receive a shock which may be rendered fatal. If, however, the enemy wore suits of copper armour, or even drenched their clothes with water before making the attack, it is difficult to see what harm Edison's jet would do, since the electricity would probably pass through their clothing to the ground. In any case the idea is not exactly novel. We read in the classics that fishermen of the Mediterranean sometimes got a shock from a living torpedo in their nets while dashing water from a wet bucket over the fish." Yes, and we read many other things in the classics too. If the writer of the "par." knows his "Terence," he will remember *fallacia alia aliam trudit*, an unconscious illustration of which he gives us. But what wonder if queer things do occasionally creep into the "science" columns of the newspapers. The men who write them *know* too much. Take last Friday's *Globe* for example: on page 6 we have almost the whole range of science covered or at least touched upon. We must remember what old Horace

said—*Nec scire fas est omnia*—which was aptly paraphrased by one of our own poets—

> One science only can one genius fit,
> So vast is art, so narrow human wit.

Some Physiological Experiments with Electric Currents.

AN important memoir embodying the results of a protracted research, was presented to the Paris Academy of Science, on December 28th, by the author, Mons. Foveau de Courmelles. The title of the memoir was as follows :—"The nascent state of bodies leaving combination under the action of electric currents utilised in physiology-elective actions." The following is a brief *résumé* of the work. Continuous electric currents decompose substances placed in contact with electrodes, and if these substances are of several kinds, action and reciprocal reaction takes place, leading to complete transformation. In his investigation Mons. de Courmelles recognised three of these, of which the following are types :—1. *Action of lithium salts on the insoluble crystals of calcium oxalate.*—If the crystals are surrounded with a dialytic animal membrane and are then plunged into a saturated solution of lithium carbonate whilst a continuous current of electricity is passed through it, they are soon found only on the exterior of the membrane. The contents of the membrane having traversed it, combines with the elements set free from the solution and forms with them more stable compounds. Unless a current is passed, no action takes place. 2. *Action of iodide of potassium upon the fats.*—If into a mass of fatty matter there be injected some iodide of potassium and then a current of electricity be passsd through it, the chemical condition of the fat changes and it becomes clotty. If the current be passed without first adding the iodide of potassium, no change occurs. 3. *Elective actions.*—If a living organism be experimented with under comparable conditions, it appears that the electricity and the substances which are produced under its influence affect the morbid abnormal tissues and carry on a modifying or destructive action upon them. This has especially been noted in cases of gout and tumour, and it seems probable that a system of medical treatment may be based upon these experiments.

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ewspapers and the Crystal Palace Exhibition.

THE want of technical knowledge displayed by writers in the daily papers when they deal with electrical matters has been so often noticed before, that it would be unnecessary to draw attention to it again, were it not for the fact that the statements made are often such as may mislead the public to their own harm. When the *Standard* in a recent issue devotes a column and a half to the Electrical Exhibition, and the economy of using high pressure is explained by the statement that "the small current is sent at a high *speed* by alternating machines, and *carries in corresponding time* the like amount of energy from one place to another," and fifty thousand volts is spoken of as "an intensity that will probably give an arc, or what would familiarly be termed a spark, of two feet long, and which would pierce the human body like a *bayonet shot from a gun*," we may be only tempted to advise a course of instruction at one of the technical schools for the writer. Surely it is not too much to ask that, if electrical subjects are dealt with, they should be dealt with by a writer who has some practical knowledge of the matter on which he discourses, or if this is impossible, that at least some effort should be made to attain accuracy by a careful reading of some of the recognised text books, and of the articles in the technical papers which bear on the subject in hand ; and if neither of these courses can be adopted, the best plan would be to leave electricity alone, and so avoid the chance of further increasing that want of knowledge which is only too common amongst the non-technical public, and which in many cases has already seriously interfered with the best interests, not only of the workers in the electrical field, but also of the public themselves.

The City and South London Railway.

THE half-yearly report of the City and South London Railway Company reveals the fact that the cost of working the line was £15,516 9s. 8d., with a gross revenue of £20,243 15s. 4d., giving a ratio of 76·6 per cent., which compares unfavourably with many of our steam railways where the expenses amount to scarcely 50 per cent. of the revenue. No mention is made in the report as to the number of train miles run, but we shall be very near the mark by computing this at 200,000 for the past six months ; this would thus give an expenditure of about 1s. 6½d. per train mile, a formidable figure for trains consisting only of three cars each. It would be interesting to know what proportion of this amount is due to traction expenses. When the line was opened we were assured that the traction costs would not exceed 3½d. per train mile, and we were under the impression that there existed a guarantee on the part of the contractors for the electrical equipment to this effect. Recently we were informed that this guarantee had not been taken up, and we surmise that the actual traction costs exceed this figure considerably. It is satisfactory to note that the traffic during the past half-year has increased by nearly 14 per cent., notwithstanding the higher fares instituted since November last. Sufficient profit was realised to pay the full interest on the debentures, and five per cent. on the preference shares, leaving a small balance to be carried forward, whilst the ordinary shareholders get no dividend. Many people predicted that the City and South London Railway would have difficulties in paying expenses, it must therefore have been a pleasure to the Chairman to announce the fact that a net profit had been realised during the second half-year of the existence of this line, and the expectations of natural increase of revenue and decrease of expenditure are by no means unwarranted by the experience gained so far. We congratulate the company and Mr. Greathead upon these results, and we wish them every success for the future.

Overhead Lines.

OUR young contemporary *Lightning* appears to think that the correspondence between the Board of Trade and various letters on the subject of the use of overhead wires, and the memorial called forth by that correspondence, is all "fudge." The affair thus designated consists of the letter to Messrs. Crompton and Co., Limited, a copy of which has been published by Major Flood Page, a memorial to the Board of Trade from the Electrical Section of the London Chamber of Commerce signed by almost everyone in the electrical profession referring to the last letter and begging that such precipitate action may not be taken, and a letter from the Board of Trade totally contradicting their first letter. If the smart young man who reviews the reviews in *Lightning* will state which of these three is "fudge," he will be conferring a benefit on electrical engineers generally and clear up a matter which at the present moment certainly requires it.

Parsons Steam Turbine.

THE letter which we publish on recent tests made with this apparatus shows how difficult it is to obtain accurate results. We hope that every effort will be made to run the turbine at its full working pressure, so that correct figures will be at the disposal of those who view the apparatus with favour and are inclined to take it up.

UNION OF ELECTRIC LIGHT AND TRAMWAY COMPANIES FOR THE SAME LINES OF ROAD.

[FROM OUR OWN CORRESPONDENT.]

IN many parts of Austro-Hungary where the erection of central stations for the electric light is projected, it is proposed also to lay out electric tram lines which are to be worked conjointly with the arrangements for public lighting. We may, therefore, expect with considerable probability that within a relatively short time electric light and tram-leads will run along the same lines of road. In by far the most numerous cases the conductors will be made aerial, since in provincial cities where electrical works and tram lines exist, underground leads cannot be expected. Under such circumstances the welcome problem is placed before the electro-technicist to arrange that in the streets where the traffic is densest no avoidable double conductors are set up for the tram line and for the street lamps, *i.e.*, not two sets of posts, pillars, supports, &c., but that both installations shall be combined, that is, fixed upon the same supports.

Proceeding from these considerations, the firm of Ganz and Co., of Budapest, have planned a combined arrangement of supports of leads for tram lines and street lamps which will be explained by the following illustrated description.

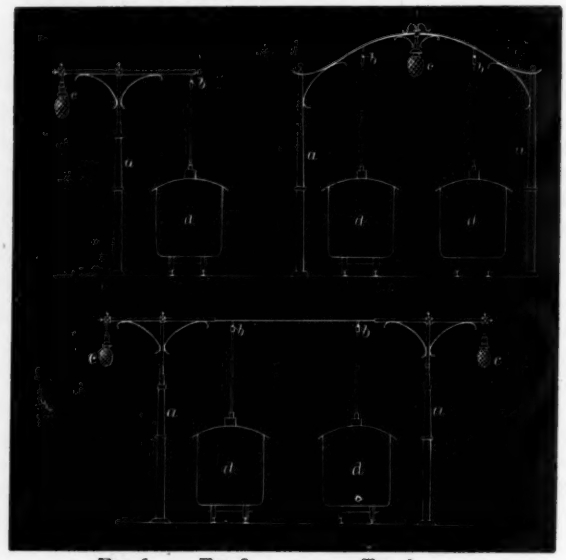


FIG. 1. FIG. 3. FIG. 2.

It is necessary to remark that this arrangement permits the same pillars, brackets, &c., which serve for the street lamps, to serve for the supply of current for the lines. The electric working of such an installation can be effected in the following ways: The combined tram and lamp installation can be connected with a common net of cable from which it receives the current. The upper leads feed both the motors of the tram cars, and at the same time the lamps fixed on the aërial conductors. The tram installation may receive the two upper leads.

Finally, the working of the tram line can be effected from a special station. On the common current supports there may be placed one or more upper conductors for the line, and at the same time one or more leads for illuminative purposes. Under certain circumstances it is permissible to feed the tramway motors and the lamps from one and the same current. The above applies to the continuous current as well as to simple or polyphased intermittent currents, or combinations of these kinds of currents. For instance, the lamps may receive alternating current from a municipal cable net or from the local circuits of secondary transformer stations. On the other hand, the tram line motors receive continuous current, which is supplied from transformers which convert the alternating current of the central station into a continuous current of any desired tension. The corresponding arrangements may be effected if a central station is established for lighting the required distance and for the traffic on the line.

From the accompanying diagrammatic drawing, figs. 1—3, it will be seen how this installation should be carried out with reference to the arrangement of the lamps and the aerial lead for the combined supply of power and light.

In all three figures the same pillars, *a*, *a*, are used, the same aerial leads, *b*, *b*, for the supply of current to the motors of the tramcars, *d*, *d*, and simultaneously to the lamps for the streets, that is for the arc lamps, *c*, *c*. In the drawings the return lead of the current is supposed to be through the rails of the tram line, so that the contact roller runs only on one lead, *b*.

THE MEASUREMENT OF ENERGY WHICH PRODUCES ELECTRICAL CHANGE.

THE *Philosophical Magazine* for the current month contains a very important paper by Dr. G. Gore, F.R.S., on a method of measuring loss of energy due to chemical union, &c. This paper is well worthy of the careful attention of all those who are interested in the development of our knowledge of electrolytes and their general behaviour: and the method therein described appears likely to be of the greatest use in the study of molecular physics.

Dr. Gore's method is applicable to the examination of a large variety of chemical and physical changes in dissolved electrolytic substances, including cases of chemical union and decomposition by whatever causes determined; simple physical mixture and dilution; the investigation of the relations of voltaic electromotive force to temperature, specific gravity, atomic weight, amount of chemical heat, &c., and it is capable of detecting small amounts of molecular change in electrolytes, such as those which occur when neutral salts are dissolved together without any manifest chemical action.

In the research which determined the evolution of this method, a number of pairs of electrolytic substances, in some cases acids and alkalies, were selected, and the conditions of the experiments were so arranged that the relative mean amount of loss and gain of energy of each pair of substances, during their act of chemical union, mixture, or mutual decomposition whilst in solution, might be measured by means of a small voltaic couple and the null method of balance, with the aid of a suitable thermo-electric pile (see *Proc. Birmingham Phil. Soc.*, vol. iv. p. 130) and an astatic galvanometer having 100 ohms resistance in its coils.

The voltaic couple consisted of a suitable positive metal and platinum, and was lowered into and raised out of the electrolyte by means of a rack and pinion. The positive metals usually employed were aluminium, tin, cadmium, zinc, and magnesium. A little improvement in the thermo-pile was used, consisting in passing a stream of cold water through a pipe immersed in the cold oil-bath, thus keeping it at a constant temperature.

The following is an outline of the method:—

1. Take a convenient quantity of an acid, such as an equivalent weight in grains, dissolve it in about two thousand grains by weight of distilled water, and measure the electromotive force of a small voltaic couple of aluminium and platinum in the liquid, calling the amount A.

2. Take a chemically equivalent weight of an alkali, dissolve it in an equal quantity of water; measure the electromotive force of the couple in the solution and call the amount B.

3. Take an equivalent weight of the salt resulting from the union of the acid and alkali dissolved in the same quantity of water; measure the electromotive force in a similar manner and call the amount C. We have now the electromotive force, A, excited by the acid, B, by the alkali, and C by the salt formed by their union.

4. Multiply the electromotive force, A, by the equivalent weight of the acid, and the one, B, by that of the alkali, add the two products together, and divide the sum by that of the two equivalent weights, and call the quotient D. C represents the mean electromotive force excited by the compound as found by means of experiment, and D that arrived at by calculation.

5. Subtract the experimental amount, C, from the calculated one D (or the reverse, as the case may be), and a difference remains which represents the relative amount of loss (or gain) of energy which has occurred during the act of chemical union, change or mixture of the acid and alkali or other substances employed, as measured by the particular positive metal.

6. Ascertain the percentage amount of loss or gain of the calculated electromotive force, D, in various cases. By this process is obtained a series of percentage numbers which we may view as representing the relative amounts of loss (or gain) of molecular energy which have occurred during the actions with the different substances under the given conditions.

Dr. Gore's method, which is thus sketched in brief, is essentially one for directly measuring the differences of mean amount of electromotive force excited by two different electrolytes, and by the liquid produced by mixing them together, with particular positive metals, before and after mixing; and as these differences must indicate the quantity of energy of some kind lost or gained during the mixing, the method is, to a corresponding extent, a means of ascertaining the amount of relative loss or gain of energy during the chemical union or mixture of electrolytes. If only one kind of positive metal be used, the method may be regarded as a system of measurement of the relative losses and gains of energy as obtained by means of that particular metal. Each positive metal is probably only affected by, and only measures the influence and changes of a portion of the molecular motion of the substances present, namely, that portion which neutralises some of the molecular motion of that metal, and converts it into electric current.

In a research on the relation of volta electromotive force to latent heat, specific gravity, &c., of electrolytes, by Dr. Gore (*Phil. Mag.*, August, 1891, p. 157), which we noticed in the ELECTRICAL REVIEW, 1891, p. 243, it was shown that in various cases of dilution or mixture of such liquid, a *gain* of mean amount of electromotive force of the two liquids occurs simultaneously with a *loss* of latent heat during the act of mixing; the kind of energy therefore measured by this method is not identical with that of heat, and as we do not know definitely of what "chemical affinity" really consists, we cannot say that what is measured is identical with chemical energy. Whilst the thermo-chemical method only measures the proportion of energy which causes thermal change, the present one only measures that which produces electric change; and it is probable that the kind of energy measured differs somewhat with each different kind of positive metal. That we are unable to define either of the fundamental kinds of energy, and that the modifications of them are very numerous, is generally admittted.

Dr. Gore, in this investigation, placed under examination a number of pairs of acids and bases, acids and carbonates, acids and salts, &c., and these were examined with different positive metals, the percentage of amounts of loss or gain of molecular energy being ascertained. All the measurements of electromotive force were brought to volts, and a method of obviating undue influence of polarisation was employed, which was identical with that described in the *Phil. Mag.*, 1890, p. 484.

A large number of experiments were conducted so that the results might be as general as possible, and great care was taken to ensure the purity of the materials.

The results are given with full details in a series of 29 tables, the substances being for the most part arranged in the usual chemical groups, in order to enable the results to be compared with the various physical constants of the elementary constituents of the compounds.

Space will not permit of our dealing at any length with the contents of these tables, and if our readers want to refer to them (which they will find it profitable to do), the original paper in the *Philosophical Magazine* must be consulted, where all details will be found. We shall, however, notice the conclusions arrived at.

Section A of the work embraced the formation of salts from acids and alkalies. It contains eight tables of numerical results. The following conclusions were deduced :—

1. In nearly every instance with acids and alkalies, whether the electromotive force was measured by means of a positive metal of aluminium, tin, cadmium, zinc, or magnesium, there was a *loss* of that force due to the act of chemical union and the proportion of losses to gains in the entire series wa 81 to 1.

2. The amount of such loss depended upon five different conditions, viz., the kind of acid, of base, of positive metal, the degree of dilution, and, to some, extent, the temperature. The losses were usually greater with all other acids employed than with carbonic; they were larger with caesia than with any other base; they were usually greater with aluminium than with any other positive metal, and with very weak solutions than with more concentrated ones, but the order of magnitude of loss with salts of potassium was nearly the same with strong solutions as with weak ones.

3. The losses were often largest with the substances of the greatest chemical energy, though several striking exceptions exist to this statement, whilst they were usually larger with hydrochloric than with hydriodic acid, and with sulphuric than with nitric, chloric, carbonic, and the halogen acids, they were greater with formic acid than with either of these; and whilst they were larger with aluminium than with tin as a positive metal, they were usually larger with tin than with cadmium, and with cadmium than with zinc or magnesium.

4. The order of magnitude of loss of electromotive force was in the majority of cases substantially the same with the different positive metals.

5. In nearly all the cases in which thermo-chemical data are given, the loss of electromotive force varied directly as that of chemical heat, as if the two forms of energy were concomitant effects of the same cause, viz., decrease of molecular motion.

6. The amount of loss did not vary regularly with the atomic weights: a result which might have been expected, for since the amounts of loss of electromotive force depend in every case upon *each* of the two uniting substances, and upon the relations of their molecular motions to each other, the amounts of loss would be affected by both.

(To be concluded.)

SOLUTION AND PSEUDO-SOLUTION: A NEW ELECTRICAL PROPERTY.

AT a recent meeting of the Chemical Society, Messrs. H. Picton and S. E. Linder contributed the first part of a paper entitled, "Solution and Pseudo-Solution," which, in the present state of the "dissociation" and "association" theories, may be regarded as desirable to be taken account of. In this paper a new electrical property was described.

The authors advance what they regard as a good *primâ facie* case for the belief that there is a continuous series of grades of solution passing without break from suspension to crystallisable solution. They hold that in the lowest grades of solution a certain loose attraction exists between the particles and the molecules of the solvent. This conclusion they support with experimental evidence gathered from their own work and from other sources.

The very finely divided particles in the lower grades of solutions (colloid solution) are regarded by Messrs. Picton and Linder as large molecular aggregates, retaining many of their molecular properties. They consider that in passing up through the different grades of solution these aggregates, on the whole, become smaller, and the forces by which they are held in solution become more definitely those of chemical attraction.

The new electrical property which is described seems to hold for a large range of solutions, extending from suspension to crystallisable solution. This property consists in the repulsion of the dissolved substance, *as a whole*, from one of the electrodes of a battery immersed in the solution. Thus, in the case of colloidal arsenic sulphide, the sulphide aggregates are repelled from the negative electrode. They are also repelled, but much less strongly, from the positive electrode.

In the case of the crystallisable colouring matter, Magdala red in absolute alcohol, a similar phenomenon was observed, but the repulsion in this case is from the positive electrode,

and there is no perceptible repulsion from the negative electrode at all.

After the paper had been read an interesting discussion ensued, in which, amongst others, Prof. Ramsay took part. He thought that the problem attacked by Messrs. Picton and Linder, was one in which pedesis, *i.e.*, the Brownian motion, played an all-important part. Pedesis, or the rapid oscillatory movement of small particles suspended in liquids, has not as yet received any satisfactory explanation; the only fact which appears to throw any light on its nature is that the addition of a salt to a solvent, rendering it an electrolyte, hinders pedesis, and finally causes coagulation and settling.

The discovery of the true nature of pedesis would in all probability be the key to the problem of the nature of solution.

The curious property noted by Messrs. Picton and Linder is not only of much interest in itself, but also as exhibiting similarities between the different grades of solution. It looks asthough there were "more in it" than has yet been described, and we should advise them to push on with their researches in this direction.

WORKING RESULTS OF THE LAUFFEN-FRANKFORT PLANT.

IN a recent issue of a Swiss paper Mr. Emil Huber communicates the results of the observations made during the working of the Lauffen-Frankfort transmission plant. It appears that the average E.M.F. at which the plant was operated was 16,000 volts, and that it was only at the close that the pressure was increased to 30,000 volts. The doubts which were at first entertained that the insulators would not be able to withstand such high pressures proved to be groundless, as interruptions only occurred about three times. In the first case an insulator became defective, or rather, was pierced at the highest tension—30,000 volts; in the second a wire broke; and in the third an insulator gave way owing, as was subsequently ascertained, to a flaw due to defective manufacture. The latter reason was also the cause of a few other insulators cracking immediately on the mounting of the installation.

It is noteworthy that these accidents only occurred with the "large" insulators provided with treble oil channels, whilst with the "small" insulators having only one channel, and which served solely as a standby in case of necessity, not one cracked or was pierced. The large insulators had to be manufactured in great haste, and small faults were therefore likely to happen. From the foregoing, says Mr. Huber, it follows that satisfactory insulation of such an installation can be obtained with relatively simple means and at moderate cost. On the supposition that 300 H.P. was yielded in Lauffen, and the whole of the energy at disposal at Frankfort was transformed into light, the cost of putting up the installation amounted to £60 per H.P., of which £50 devolved upon the conductors.

The principal question is, how much of the energy produced in Lauffen was usefully applied in Frankfort. During the working of the installation, regular and simultaneous observations were made in Lauffen and in Frankfort of the measuring instruments on the switchboards. On the Lauffen board on I., II. and III. conductors were read 500, 490 and 500 ampères respectively; pressure (measured between one conductor and the neutral point on each of the three conductors), 54 volts. If the phase movement between the strength of currents and pressures is left provisionally unconsidered, the result is a mean performance of 80,500 watts. At the same time 1,060 incandescent lamps of 16 normal candle-power, or their equivalent, were alight in Frankfort, the consumption of energy being 58,000 watts. The efficiency worked out on this basis amounts to 72 per cent. The efficiency is, however, stated to be higher by about 5 per cent.

This result, although it leaves in doubt a certain percentage which would only render the efficiency higher, is satisfactory, and the installation has been very successful. Even foggy weather had no effect upon the transmission, and no direct leakage to the earth was noticeable, the instruments indicating completely the same as in dry weather. Nothing abnormal in the plant or the conductors occurred, and Mr. Huber concludes that the experience derived forms a solid basis for the execution of similar installations and for further progress in similar directions.

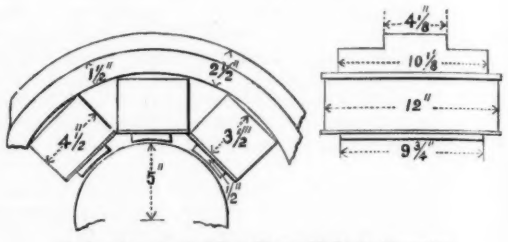
MAGNETIC LEAKAGE IN DYNAMOS AND MOTORS.* †

BY ARTHUR STANLEY IVES.

(*Concluded from page* 62.)

IV.—100-LIGHT FORT WAYNE ALTERNATOR.

A single pole and coil are shown in fig. 7.



Single pole and coil of Fort Wayne 100-Light Alternator.
FIG. 7.

In this case the following measurements were obtained:

TABLE V.

Position of coil.	Number of turns:	Means (of 10) deflections.	Deflection per turn.	Percentage of maximum.
Yoke	12	312·50	26·042	98·3
Yoke end of field coil	10	264·90	26·490	100·
Middle of field coil ...	10	256·80	25·680	96·9
Pole end of field coil...	10	224·45	22·445	84·7
Core (field)	10	196·10	19·610	74·0
Armature	10	190·80	19·080	72·0
Total side leakage (each side)	10	32·25	3·225	12·2
Total end leakage (each side)	75	27·00	0·360	1·4

Conclusions:

1. Leakage found:

	Sides =	24·4 per cent
	Ends =	2·8
Total leakage observed directly	=	27·2
Total loss (subtracting armature from maximum)	=	28·0
Unaccounted for	=	0·8 per cent.

2. It is curious to remark that in this machine the maximum magnetisation is not at the middle of the field coil, as in all the other machines tested, but at the end nearer the yoke. This is probably due to the angle which the axis of the coil makes with that of either adjacent one.

3. The leakage from the yoke is very small indeed, only 1·7 per cent.

4. We require 139 per cent. of the effective magnetism to be produced by the field.

* Graduation thesis in the Electrical Engineering course at Columbia College, 1891.

† New York *Electrical World*.

V.—400-LIGHT EDISON DYNAMO.

Fig. 8 will give a clear idea of the proportions and design of this machine.

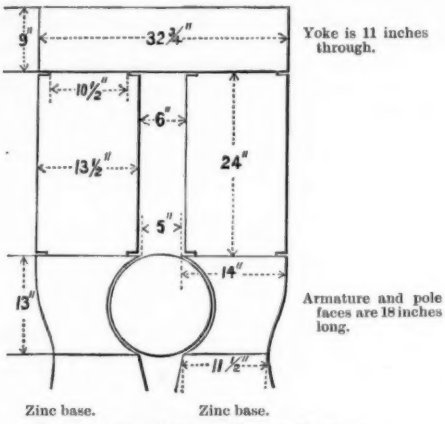


FIG. 8.—DETAILS OF 400-LIGHT EDISON DYNAMO.

The tests on this machine resulted as follows :—

TABLE VI.

Position of coil.	Number of turns.	Mean (of 20) deflections.	Deflection per turn.	Percentage of maximnm. With normal field current.	Percentage of maximnm. With ¾ of normal field current.
Middle of field coil	5	319·	63·80	100·	100·
Yoke end of field coil	5	288·45	57·69	90·4	92 3
Yoke	6	304·70	50·78	79·6	82·8
Pole end of field coil	5	265·45	53 09	83·2	86 8
Armature	6	229·50	38·25	60·0	63 7
Outside ¼ of lower ½ coil	25	47·50	1·90	3·0	...
Inside ¼ of lower ½ coil	25	74·80	2·99	4·7	...
Front or back ¼ of lower ½ coil ...	25	51·00	2·04	3·2	...
½ back of pole piece	25	52·20	2·09	3 3	...
Each side of pole piece	25	55·40	2·22	3·5	...
Base of pole piece	10	43·60	4·36	6·8	...
Across upper pole points	25	13·	0·52	0·8	...
End of yoke ...	25	55·80	2·23	3·5	...
Top of yoke... ...	25	34·30	1·37	2·2	...
Each side of yoke	25	29·80	1·19	1·9	...

The figures in the last column are the final results of a partial set of observations taken with only about ¾ of the normal field current through the field coils.

With regard to this machine we observe as follows :—

1. Leakage from lower half coil ... = 14·1
„ „ pole piece :
Back = 6·6
Sides = 7·0
Base = 6·8
Across points = 1·6 — 22·0

Total leakage found directly = 36·1
Loss (by subtraction) from half coil = 16·8
„ „ „ pole piece = 23·2

Total loss (subtracting armature from maximum) ... ... = 40·0

Unaccounted for = 3·9 per cent.

2. Leakage found from Yoke :—
End = 3·5
Top = 2·2
Sides = 3·8

Total found directly = 9·5
Loss from yoke (by subtraction) = 10·8

Unaccounted for = 1·3 per cent.

3. Total loss (by subtraction) from middle of field coil to middle of yoke = 20·4 per cent.

4. The leakage from the half coil nearer the pole piece is distributed around the circumference in about the ratio given by fig. 9.

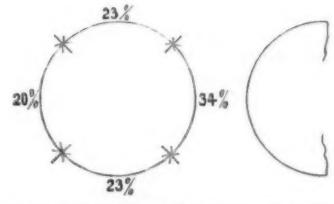


FIG. 9.—LEAKAGE ABOUT THE POLE PIECE IN EDISON DYNAMO.

5. We require 166 per cent. of the effective magnetism to be produced by the field.

6. An increase of 33 per cent. in the field current gave only 3·7 per cent. more loss. This increase in current, however, only produced 21 per cent. increase in maximum magnetisation, the smaller current giving a deflection of 52·56 per turn at the middle of the field coil.

7. The greater discrepancy in the results obtained for this machine (as compared with the others) is no doubt due principally to the difficulty found in making a clean break in field circuit, the lever of the knife switch being short and the flash quite intense. Hence, to render this of as small account as possible, 20 readings were taken in each position of the coil to obtain a mean. The character of the reading could be readily told by simply observing the amount of flash on breaking the circuit ; and *vice versâ*, the intensity of the flash (or the cleanness of the break) could be as surely told by observing the variation of any single deflection from the mean. With this in mind, it will be seen at once that we may with perfect confidence discard observations which are evidently inaccurate, or weight the others so as to accomplish the same result. If, selecting the simpler method, we retain from each set only those readings which have presumably been produced by a proper break, and take their mean, we shall obtain the following, instead of the results of Table VI. :—

TABLE VII.

Position of coil.	Percentage of maximum.	Position of coil.	Percentage of maximum.
Middle of field coil ...	100·	Leakage from back ¼ of lower ½ coil.	3 3
Yoke end of „ ...	90·		
Yoke	80·1		
Pole end of field coil	85 1	Leakage from back of pole piece	6 6
Armature	61·1		
Leakage from outside ¼ of lower ½ coil.	3·1	Leakage from (both) sides of pole piece	7·2
		Leakage from base of pole piece	7·1
Leakage from inside ¼ of lower ½ coil.	4·9	Leakage across (upper and lower) pole points.	1·8
Leakage from front ¼ of lower ½ coil.	3·3	Leakage at end of yoke	3·5
		Leakage at top of yoke	2·2
		Leakage from (both) sides of yoke ...	3·8

Taking the sum of the leakage between middle of field coil and armature found directly, as given in Table VII., we find a total of 37·3 per cent., and total loss (subtracting armature from maximum) being 38·9 per cent., leaving unaccounted for 1·6 per cent., instead of 3·9 per cent., as before.

Again, the total leakage found from yoke end of field coil to middle of yoke equals 9·5 per cent., and total loss (subtracting yoke from yoke end of field coil) from Table VII. equals 9·9 per cent. ; unaccounted for, 0·4 per cent.

These latter results are quite within the limits of observation, and from previous considerations are in all probability the most accurate.

TABLE VIII.

Machine.	From maximum to armature.		Loss (by subtraction) from maximum to yoke.	Ratio of maximum to effective magnetism.	Total current.	Field current.	Percentage of energy in field.	Percentage of energy lost in field due to leakage.
	Loss (by subtraction).	Leakage found directly.						
½ H.P. Crocker-Wheeler motor	28·7	.....	.....	1·40	2	·25	12·5	3·5
3 H.P. Crocker-Wheeler motor	17·4	16·6	5 (est.)	1·21	24	·38	1·6	0·3
400-light standard dynamo	24·2	23·1	12·3	1·32	220	10·6	4·8	1·2
100-light Fort Wayne alternator	28·0	27·2	1·7	1·39	...	...	...	...
400-light Edison dynamo (with ¾ of normal field current)	36·3	.....	17·2	1·57	...	5·2	...	...
400-light Edison dynamo (with normal field current) *mean values*...	40·0	36·1	20·4	1·67	220	7·2	3·3	1·3
400-light Edison dynamo (with normal field current), *preferable values*	38·9	37·3	19·9	1·64	220	7·2	3·3	1·3

SUMMARY.

The summary given in Table VIII. of the results obtained above may be convenient for comparison.

Of course the detailed search for the leakage (in addition to its determination by subtraction) is of value in locating its distribution more definitely, but its principal use is as a check to the other results.

The chief interest, however, in this investigation, from an economic standpoint at least, centres in the fifth column of Table VIII., which gives the amount of magnetism which must be produced by the ampère turns in the field in terms of the number of lines of force required to pass through the armature—which is nothing more nor less than the *leakage coefficient* (λ) of Hopkinson, which he uses in determining the ampère turns required for the field. A complete set of these values for all forms (and sizes) of field magnets would be perhaps as valuable an addition to dynamo data in hand as any that could be made, and this method of obtaining them seems to offer advantages superior to any heretofore used.

One effect of this leakage is given in the last column of the same table, namely, the decrease in the running efficiency of the machines due to the fact that extra current energy is of course consumed by the field. It must not be supposed, however, that this waste of energy is the only or even the most injurious result of magnetic leakage, for there are at least three others.

1. It will be seen at once that if only 75 per cent. of the magnetism produced by the field passes through the armature, there will be a considerable amount of iron and wire in the field which is employed to no purpose; in other words, there will be waste material in the field with all its attendant disadvantages.

2. Since the lost magnetism becomes scattering lines of force in the neighbouring air, we know that watches and electro-magnetic instruments of all kinds in the vicinity will be affected thereby.

3. Those lines leaking from the points (or horns) of the pole pieces are liable to enter the armature at the neutral space, and so cause sparking.

This question of leakage, then, from more than one standpoint, is a most important one, and well deserving of careful attention and investigation.

It has been suggested that an error is introduced by the fact that no account is or can be taken of the residual magnetism in the circuit, and that all the lines of force are not withdrawn when the primary circuit is broken. It will, however, be evident on second thought that the residual magnetism is no different from any other, and forms a closed circuit through the iron in the same way, so that it is probable that the distribution in all parts is proportional, or very nearly so, as the residual is in the smaller machines not over 1 or 2 per cent., and in the Edison not over 4 per cent. of the normal magnetisation, and we have seen that an increase of 21 per cent. in the magnetisation of the Edison only produced an increase in per cent. lost of 2·6 per cent. (taking the more probable values). So a maximum error of ½ of 1 per cent. may perhaps be laid to residual magnetism, but no more, and that is for our purposes negligible.

To conclude, since no one doubts the accuracy of the ballistic method, as a final check on the accuracy of the method proposed, two or three sets of readings were taken with a galvanometer having a time of vibration of nearly 12 seconds, and a logarithmic decrement of less than 0·01, on the 3 H.P. Crocker-Wheeler motor with the following results :—

TABLE IX.

Position of coil.	Percentage of maximum, voltmeter method.	Percentage of maximum, ballistic method.
Middle of field coil...	100	100
Pole end of „ ...	96·1	96·1
Armature	82·6	82·7

Column 2 is taken from Table III.

This is a most remarkable and highly satisfactory agreement.

AUSTRALIAN NOTES.

[FROM OUR OWN CORRESPONDENT.]

THE specification for the lighting of Melbourne by the municipal council is just out. It provides for both arc and incandescent lamps to be run on the same circuits, the incandescent lamps to be run in series with the arc lamps. There are to be fifteen dynamos, each capable of running from fifty to sixty 1,200 nominal candle-power arc lamps at a speed of 1,000 revolutions per minute, and to be so regulated that arc and incandescent can be run in series. For lighting the streets 633 arc lamps and about 1,500 incandescent lamps will be used : the arc lamps to be 1,200 nominal candle-power and to run sixteen hours without being recarboned, the globes to be of clear glass, hanging boards to be fitted with a switch for cutting out the lamps, and each lamp is to be protected with a hood. The specification provides for five hundred series incandescent lamps, each of 32, 25, and 20 candle-power guaranteed to burn one thousand hours, and to be so constructed that in the event of the filament breaking, the current will find an easy passage through the lamp. These lamps will be protected by glass globes, and have a tin reflecting shade. Four switchboards are required with plug connections to connect any circuit to any dynamo, and to be mounted on incombustible bases. The ammeters, one for each dynamo, will be required to read to double the normal current. The list of articles required concludes with 40 lightning arresters, three spare armatures, 20 sets of spare brushes, and two spare sets of regulating apparatus for dynamos.

The conditions on contract seem to be very fair, the plant, of course, to be tested and approved by the inspecting officer of the council, and as regards payment, 75 per cent. of the amount of contract will be paid on receipt of the bill of lading, and the balance of 25 per cent. to be paid 60 days after sight of bill of lading, giving the council an opportunity of enforcing any claims for fines, &c.

The specifications for cables and for engines and boilers have not reached me yet.

Affairs here are still very dull, and none of the firms have any too much work on hand. Messrs. Kingsbury & Co. are engaged on installing about 30 Brockie-Pell arc lights at the

Clyde railway sidings for the Railway Commissioners. The Crompton Electric Supply Company are engaged on putting in a 300-incandescent light plant at a wool store on the north shore. The Williamson Electrical and Engineering Company still have the Redfern lighting and some arcade work on hand, and the Electrical Material Company are wiring the Federal Coffee Palace for a 200-light plant. Unfortunately we have now a Protectionist Government in power, who immediately clapped on a duty of 10 per cent. on nearly everything, including all machinery, and a meeting of the electrical trades was called to decide what united action could be taken in the matter; but up to the present nothing very definite has been arranged.

A THERMO-ELECTRIC STANDARD OF ELECTROMOTIVE FORCE.

THE proposition to utilise thermo-electric couples as standards of electromotive force has been *sur le tapis* for some time; but such as have hitherto been employed having depended upon the use of two metals, the electromotive forces thus obtained are extremely feeble and vary with the particular specimens of metal employed.

The subject has recently been approached by Mons. Henri Bagard from an entirely new point of view. He has sought to discover whether a thermo-electric element constituted by two liquids, that is to say, by two bodies presenting an invariable composition, possesses for two determined temperatures of the points of contact a well defined electromotive force.

By taking for the liquids an amalgam of zinc containing 0·0005 of zinc to 1·0 of mercury, and a solution of sulphate of zinc saturated at zero, a considerable electromotive force was obtained by Mons. Bagard, the element being incapable of polarisation. Here is the description as given before the Paris Academy of Science.

The zinc is dissolved in the mercury under a layer of zinc sulphate, which latter impedes oxidation, and can be easily removed when the amalgamation is completed by means of blotting paper.

The apparatus is constructed as follows:—The amalgam and the zinc sulphate are placed in thin tubes, A, B, C, closed at their lower ends; the tube, A, is brought to the temperature of boiling water under the atmospheric pressure, this temperature is called T; the tubes, B and C, are kept in melting ice. The sulphate in A communicates with that in B by means of a siphon filled with the amalgam. Two electrodes of platinum are plunged in the amalgam in B and C, between which there only exists a thermo-electric difference of potential. The sulphate which covers the amalgam in C, is destined to protect it from alteration on contact with the air; the sulphate in A is covered by a layer of paraffin to protect it from evaporation. In this couple the warm amalgam is the positive pole.

Mons. Bagard prepared several couples, and compared them together at different times, and he found that they gave an electromotive force of nearly 0·0001 volt in each case, and did not polarise. It is evident, therefore, that the couple could serve as a standard.

When one of the surfaces of contact was maintained at 0°, whilst the other was raised successivly to temperatures, t, varying between 0° and T, the following results were obtained, the value of T being really 99·3°.

t ... ...15·7°, 33·6°, 40·7°, 48·6°, 54·3°

$f(t) = \frac{E_0'}{E_0^T}$ ... ... 0·148, 0·320, 0·392, 0·470, 0·528.

By taking T = 99·3°, the function $f(t)$, is strictly represented by the formula

$$f(t) = 0{\cdot}00930 \cdot t + 0{\cdot}00000774 \cdot t^2 \qquad (1)$$

Thus the representative curve is, as in the case of most of the bi-metallic couples, a branch of the parabola, and this curve turns its convexity towards the axis of the temperatures.

Mons. Bagard has also measured in absolute value the electromotive force, E_0^T, of the standard couple, by compensation with the difference of potential produced at the extremities of a resistance equal to the legal ohm, by a convenient current, of which the intensity was measured by the electrolysis of silver nitrate by the aid of a capillary electrometer sensible to the $\frac{1}{10000}$th volt. He thus found as a mean of several measurements, using the formula (1),

$$E_0^{100} = 0{\cdot}1167 \text{ volt},$$

the error to be feared on this result being 0·0001 volt.

The value of E_0^{100} is then about a hundred times greater for this particular couple than for the iron-copper couple which gives about 0·0011 volt.

An expression for the electromotive force for the temperatures comprised between 0° and 100° was now found, namely:

$$E_0' = 0{\cdot}001077\ t + 0{\cdot}00000090\ t^2. \qquad (2)$$

In determining the influence of the percentage of zinc in the amalgam Mons. Bagard compared with the standard couple several other couples containing different amalgams, using the method of opposition already employed; when the proportion of the zinc is less than 0·00005, the element is polarisable. For the higher values the element becomes unpolarisable and the electromotive force diminishes in a continuous manner and proportionately to the increase of the zinc, as is shown by the following table of results.

Quantity of zinc to one of mercury	0·00025	0·00035	0·00045	0·00050	0·00055	0·00075
E_0^{100} ...	0·1197	0·1183	0·1171	0·1167	0·1164	0·1150

Mons. Bagard argues that his couple is absolutely constant between the two given temperatures, and shows that it can be closed without polarisation. Its electromotive force is given by the formula (2) for temperatures between 0° and t°. It is evident, moreover, that it is unnecessary to weigh out the zinc for solution in the mercury with any great precision, since the preceding table shows that the variation of E_0^{100} does not attain to 0·0001 volt when the proportion of the zinc varies from 0·00001 or from $\frac{1}{50}$th of its value.

This research has been executed in the Physical Laboratory of the Faculty of Science at Nancy, and is fully reported in the *Comptes Rendus*, vol. cxiii. p. 849.

ELECTRIC LIGHTING AT ODESSA.

[FROM OUR OWN CORRESPONDENT.]

IN the city of Odessa an Act has recently come to pass in the region of electric lighting which is perfectly without parallel in peculiarity, and deserves to be made known in the widest circles. I will give you a brief description of this most interesting affair for the edification of your readers.

The magistracy of the city in question about five years ago caused a central station to be erected, which was in the first place, to supply the imposing city theatre with electric light. The station was erected at about the distance of 1½ kilometres from the theatre, and on this account—as well as because other establishments could in time be connected—it was carried out on the alternating current system with transformers. The entire installation was effected by Ganz & Co., of Budapest, who at the same time, according to agreement, undertook the working for a term of 10 years against payment by the city.

In this manner the city was set free from all the trouble which the management of electrical works involves, and the state of things which ensued caused the city in some degree to forget that the works erected at its own cost was, strictly speaking, its own property, and that it was consequently the policy of the city to see to the further prosperous development of its own works.

The establishment has been working for close upon five years with full satisfaction, and in course of time so many lamps have been connected with the conductive net for the illumination of shops, clubs, smaller theatres, &c., that the machines of the central station are burdened to the full extent of their capacity so that the installation is at present without any reserve. This circumstance joined to the continued increase of the demand for electric light has shown for some time the necessity of an extension of the works. Yet, although these works showed very favourable results, both technically and financially, the city deriving a handsome net profit from the receipts, it still hesitated to carry out the extension, always expecting that they would be

undertaken by the managing firm on its own account, or, at least, that the firm should make proposals to that effect.

The Paris Edison Company now made proposals to the city for the erection of electrical works in the most elegant quarter of Odessa, and these proposals met with the support of the Mayor of Odessa, who has always in a munificent and self-sacrificing manner sought to promote the development of the city. Finally, the Mayor declared himself ready to take part in this central station to the extent of 50,000 roubles in order to facilitate its completion. But as he could not in his capacity as Mayor participate in this manner in an undertaking which would enter into agreement with the city, he placed the above-named sum at the disposal of the city, which was to participate in the undertaking, and pay him 6 per cent. interest on the 50,000 roubles, that is if the concern should obtain a profit of at least 6 per cent. If the undertaking yielded a profit less than 6 per cent. or none at at all, he should claim no interest. The city was thus guaranteed by its mayor against all risk, as in case of a loss he had agreed to bear at his own cost the demands payable in proportion to the sum contributed. Simultaneously a draft agreement was entered into with the Parisian Edison Company, the chief conditions of which are here reproduced.

1. The Municipality of Odessa invests in the undertaking a capital of 50,000 roubles.

2. The Edison Company participates to a like amount in the form of machinery, materials, and underground canalisation according to its real value.

3. Neither the municipality nor the Edison Company engages to increase the capital invested.

4. If the municipality in future wishes to enlarge the undertaking, it must invest a further capital of 30,000 roubles.

5. The municipality of Odessa places at the gratuitous disposal of the above company a plot of land of 300 square fathoms (Faden) on the Nikolai Boulevard, near the town hall.

6. The duration of the agreement is 15 years, or in case of enlargement 25 years.

7. The price for the current to be furnished will be based on the measured consumption, but it must not exceed the present prices fixed for gas lighting.

8. The sum paid by the consumer per lamp installed along with leads, but not including electroliers, must not exceed 20 roubles.

9. Within the radius of a kilometre around the station the Edison Company, under the present conditions, has a privilege as against other undertakers.

10. The granting of concessions for lighting beyond the radius named, and right of laying down leads even within the Edison radius, remains at the option of the municipality, but it may not concede to any undertaking conditions more favourable than those of the present agreement.

11. The stipulations of the present contract do not relate to the working of the existing municipal central within the circuit which it occupies up to November 30th.

12. The company is bound to obtain its materials exclusively from Edison and Company, who are bound to allow the following discounts on their price list:—

On motors	5	per cent.
Materials for installation ...	10	„
Glow lamps	10	„
Carbons for arc lamps... ...	10	„

14. The municipality agrees to install for the entire term of the agreement at least 500 Edison lamps of 10—16 normal candles in the Town Hall, the Library, &c.

15. The company agrees to instal, provisionally, 100 Edison lamps in the Town Hall by December 15th—20th, *force majeure* excepted.

16. The dynamos, engines, &c., will be obtained from the French Exhibition at Moscow.

17. The Edison Company undertakes the commercial management of the undertaking.

18. The Edison Company has also the right to undertake the technical management.

19. By permission of the municipality the company may lay a part of the leads above ground.

20. The concession may not be handed over to any third party except with the sanction of the municipality.

This draft agreement was accepted by the Town Council with a few modifications of little importance, although only after a hard struggle, and the city of Odessa, by erecting a second electrical works, is now competing with itself, and this on the more unhealthy basis, as the present works are acting excellently, and being founded on the system of conduction to a distance is eminently capable of extension, and is able to meet the demand for the entire city, whilst the second establishment, now in course of erection, will work with continuous currents of low tension, and consequently supply electricity only over a relatively limited area.

The city of Odessa already feels the effects of the false step taken, as the necessity arises, of providing the municipal hospitals and other establishments too distant from the Edison works with the electric light, so the town must now, after all, enlarge its own original central station when the erection of the new central station just resolved upon must appear absolutely purposeless.

The city of Odessa has, therefore, began a damaging competition with itself, and has given the world an instructive lesson *how not to do it*.

THE WIRING OF HOUSES FOR THE ELECTRIC LIGHT.

By E. C. S.

APPENDIX.

SINCE the appearance of some notes on the subject of the wiring of houses for the electric light in this journal,* the author has been asked to express his views on the manner of erecting wires in a house at greater length and in more detail, as, it is true, this matter was rather summarily disposed of in the article in question, in which the leading general principles only were mentioned.

1. The idea that the running of wires for the electric light is as simple and "cut and dried" an operation as mechanical bell-hanging, is fast becoming very widely spread among untechnical men. To those who have had any experience in such matters it is needless to insist on the absurdity of such a view, but as the author is addressing himself in these lines to *users* of the electric light, he may be forgiven for pointing out the chief reasons why it is absolutely necessary that care and discrimination should be exercised in the choice of *position* for the wires as well as in the design of the circuits.

It is not until quite recently that experts have begun to recognise the great importance of running the wires in such a manner as to render them readily accessible, so that they may be easily traced for inspection in the future, and, indeed, the author is of opinion that electrical engineers are not even now sufficiently alive to the possible consequences of leaving the choice of the positions of the wires too much in the hands of the builders or contractors.

Wires for electric light are distinctly delicate things and require skilled handling. Wires cannot be subjected to the same treatment, with impunity, as gas barrel, or bricks or blocks of stone, or floor joists, &c. They must not be thrown about roughly or left out in the rain for days at a time. A coil of wire must not, further, be made a resting place for saws, planes, chisels, or other edged tools, for the most obvious of all reasons, namely, that the insulation is thereby very apt to be injured, if not quite destroyed in places.

Nobody would think of beginning to plaster before the brickwork was complete or to commence papering part of a room, simply because the plaster was dry in that part, before the whole room was ready, or to put furniture in before the carpets were laid, or to hang pictures before the proper time, or to commit any equivalent well-recognised absurdity, and yet, because the nature of electric wires and the far reaching subsequent evils attendant on carelessness and ignorance in running them are not so well understood (except by those who have had experience in the matter), it is very generally thought that electric wires can be run anywhere and at any time during the building of a house.

An architect does not usually trouble himself much about the future convenience or comfort of his client, as far as electric light is concerned, his main idea being to let nothing interfere with the symmetry of the elevations and sections of

* See ELECTRICAL REVIEW, January 1st, and 8th.

the house he is designing. Hence his dictum is, that such things as casing, fuses, switches and the like, must be stowed away somewhere—concealed in the walls, hidden behind panelling, between floors—anywhere, only *out of sight*. The builder in whose hands the wiring is often put, treats the matter very much like any other contract—for gas, or hot water, or draining, or plumbing—gets tenders from a few firms, and specifies only that the wires are all to be hidden, or else "he will hear about it from the architect." In these days of competition—and nowhere is competition keener than in the electric wiring trade—the ultimate result of this can easily be foreseen. The inspector for the insurance company is invited to inspect the installation, *after it is finished*, which means, of course, that he can only inspect lamps, fittings and switches, and, may be, a stray fuse or two, while such matters as the method of distribution, number, position and character of the fuses, the quality of the insulation on the wires, the amount of copper in the wires, and the nature and workmanship of the joints in the wires and of the installation generally are obviously "uninspectable," and hence these details are left either to the conjecture of the inspector or to the memory of the contractor. When the inspector tests, he may find a low degree of insulation, but this, naturally, is entirely due to the moisture in the walls, or to the weather, or to something quite beyond the control of anybody. He may find a short circuit, and then, if the installation has been carelessly carried out, it may require the digging out of a good deal of the casing (if it has been concealed in the walls) before the fault is localised and remedied, which means a considerable amount of expense and annoyance to the client, who perhaps has just had his house nicely decorated throughout, and who, possibly, has been the innocent cause of the whole disturbance, though probably he may never be induced to believe that merely driving a nail into a part of the wall (that contained the casing) to hang a picture by—because he found the nail held better there than in the plaster—could have "made such a difference to the wires."

It is obvious that if the inspector's opinion is to be worth anything either to the insurance company or to the client, the work should be inspected periodically during execution, as it is manifestly beside common sense to expect an inspector to be gifted with some new sense which will enable him to judge of the quality of work from its external appearance. All the tests in the world after completion cannot be of such real value as periodic inspection and testing during the progress of the work.

The author cordially endorses Mr. Musgrave Heaphy's first rule, viz., that wherever possible wires should be run on the surface, and be readily accessible. Of course walls *have* to be pierced very often, and much cutting away can be saved by placing porcelain tubes through the walls when the house is being built, the tubes being plugged at both ends and the plaster being rendered flush with the ends. But beyond such mechanical preparations as these, it is most unwise to commence actual wiring, while workmen performing other classes of work are still in the house—especially in a large house where the wires are a good deal scattered. So many "accidents" may happen which *may* show themselves at once on testing, or may only become apparent as time goes on. Electric wires are not treated by workmen belonging to other trades with proper consideration. They use them to hang their gas tongs on temporarily, or while finishing the woodwork of a door a chisel slips and cuts the insulation of a neighbouring wire, or the hot-water man finds there is just room in one of the grooves of the casing for a bend of his gas barrel, so he takes off the capping and runs his pipe, or the mechanical bell man finds that the casing is in a direct line with his wire, so he bores a hole through everything, or screws a bell crank on to the casing, and the ends of the screws find a resting place in the insulation of the cable, and then the plasterer comes and covers over all these sins, making everything smooth and bright. The fire insurance company's inspector next arrives, but *sees* nothing to take exception to, and finally the client returns from the Riviera, or some other part of the world, and praises everybody all round for the neatness and care with which the wires have beeen so adroitly kept "out of sight." Alas! poor client! may you not be condemned some day to fast in fire till the crimes done in those days of wiring are burnt and purged away! for your own sake as well as that of the insurance company.

But supposing everything to be right at the commencement: out of sight very soon becomes out of mind, and it is obvious that in years to come the localisation of a fault in the wires due to a burst water pipe or a settlement in the house or other cause (which fault may occur at some distance from the cause) will involve serious trouble, inasmuch as there is nothing to shew where the wires are—they have been so carefully hidden—and it is not to be expected that the man who ran the wires can remember exactly where he put them, even if he could be got hold of on an emergency. Moreover, there is no doubt that it is very tempting to gloss over work which is to be concealed, which would not be passed were the wires to be run on the surface.

To sum up, the author may state as his opinion that there can be *no advantage* in concealing wire that is not more than counterbalanced by the risks of future trouble and inconvenience inseparable with such a procedure.

If the house is in process of construction advantage may be taken of this circumstance to make as many preparations for future running of wires as will save cutting away, but on no account should *wires* be introduced until all workmen engaged in plumbing, or running hot water pipes, or other kind of mechanical work of a heavy nature, or of a nature calculated to entail risk of injury to the wires, have completed their work and left the house.

The plaster and the house generally should be allowed the longest possible time to dry before the wires are put in.

The best time to run wires is just before the house is to be papered and decorated, as then all casing showing on the walls can be papered over or painted so as to harmonise with the rest of the room, in which case surface work can very often be rendered quite unnoticeable to a stranger while remaining readily traceable in case of need. Besides this, several further precautions should be taken according to circumstances which will be suggested by the judgment of the consulting engineer.*

The method of wiring which the author has always adopted and which, he is glad to find, is every day becoming more widely recognised as being a satisfactory, indeed the only satisfactory method, is so simple that it can be described in a few words.

The mains from the source of supply are brought to a main distributing fuse board immediately on entering the house. From this board 5 ampère circuits are taken off protected by a fuse on each pole; each of these circuits terminate in a local distributing fuse board whence leads are taken off again through a fuse on each pole to individual lamps or groups of lamps controlled by one switch. The switches, of course, may be placed anywhere, as usual.

This system possesses superlative advantages as regards *safety*, simplicity, and, the author believes, economy, as although more wire and larger casing is used, it is permissible to use wire of less quantity of insulation (the quality always remaining the best) for the branch circuits than under other systems and the absence of joints in the wires, all joints being made at the fuse lamp and switch terminals and causing a great saving of time, labour, and materials.

As regards inspection by insurance offices.

Insurance companies should employ a properly qualified and experienced technical man to inspect for them. They should insist on seeing the specification for the wiring before the work is commenced, and they should stipulate for power to inspect at odd intervals during the progress of the work. Under these conditions, properly carried out, there should be no need for the correspondence lately appearing in technical journals *re* liability of contractors for the future working of an installation

This is not the place to discuss such a matter, but the author may just state his appreciation of the absolute injustice of holding a contractor liable for faults in his work discovered

* If the house has been built a good many years there is usually very little choice as to position of wires, they generally must be run on the surface. The same remarks apply in the main, but usually one knows the worst about an old house, and damp places can be avoided when running the wires, and such a multiplicity of precautions need not be taken as in the case of a newly-built house whose weak points in regard to damp, settlement, or other objectionable things are not immediately apparent. The author generally takes the precaution of rendering assurance doubly sure by specifying, even in parts where the absolute necessity is doubtful, that only the best seasoned American whitewood, shellac varnished inside and out, be used.

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in the future, unless it can be shown that such faults are due to *mal praxis* on the part of the contractor.

People who know nothing about the matter should employ a properly qualified man to advise them.

A properly qualified man should be able to give an opinion on the quality of the work done.

Hence the insurance company's inspection means nothing if it does not, with the above reservation, transfer the responsibility for the future to the insurance company.

FAST SPEED WORKING ON SUBMARINE CABLES OF MODERATE LENGTH.

By P. CHR. DRESING, of the Great Northern Telegraph Company.

THE ELECTRICAL REVIEW of July 13th, 1888, contained a short description of the special kind of recorder (the so-called undulator) adopted by the Great Northern Telegraph Company as a receiving instrument on all their cables up to about 500 knots length.

The undulator has, within the last two years, undergone some very important improvements, and as these constitute a decided advance in this kind of apparatus, I hope that the following particulars will prove of interest to some of the readers of the REVIEW.

Figs. 1 and 2 show the principal parts and their mutual

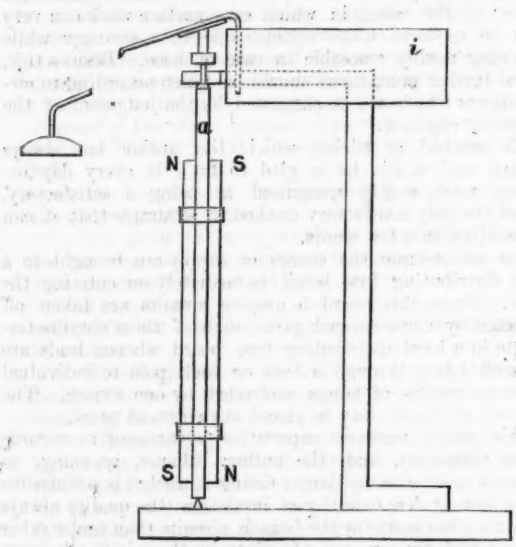


FIG. 1.—ELEVATION, THE ELECTRO-MAGNETS REMOVED.

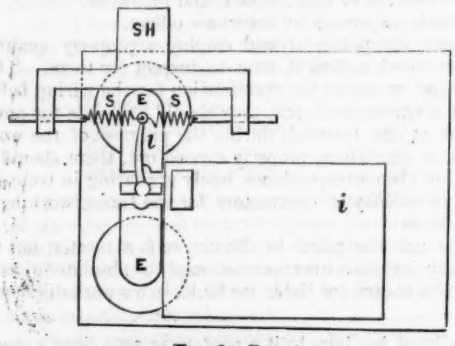


FIG. 2.—PLAN.

position and relation. The x-shaped steel armature of the old instrument (see the REVIEW of July 13th, 1888) is replaced by a strongly magnetised steel armature, consisting of two straight bar magnets, N S and S N, fixed close to the vertical axis, a, to which they are fastened, parallel to each other, and with their dissimilar poles opposite. This reduces the moment of inertia of the armature to a minimum, without in any way lessening the magnetic efficiency, and it further admits of the application of two electro-magnets instead of four, as formerly, so that the mechanical stability of the instrument becomes greatly augmented.

The metallic siphon of the old instrument is exchanged for a fine glass siphon about 4 inches long, which dips in the ink reservoir, i, after the style of Sir Wm. Thomson's recorder. The reservoir can be lowered at will by means of a rack and pinion to suit the siphon.

The armature is kept in position by means of two fine spiral springs, S,S, which can be adjusted by the movable holder, S, H.

The electro-magnets, E, are adjustable in the usual manner.

The effect of these several modifications is that the instrument records perfect signals at the rate of 100 words a minute on 500 nautical miles of cable, the sending instrument being a Wheatstone automatic transmitter. The sensitiveness of the instrument is also increased 5 or 6 times, and it works well with a current strength of ·07 milliampère.

A great number of experiments on the company's English-Swedish cables (about 520 knots long) prove without doubt that the highest efficiency of the undulator is attained by sending continuous currents—*i.e.*, the Wheatstone automatic transmitter working as a double current key—and by inserting a condenser of about 10 microfarads, shunted by a resistance of about 2,000 ohms, between the undulator and earth at the receiving end.*

In conclusion, I may add that the above-mentioned improvements of the instrument are due to Mr. F. L. Nielsen (mechanician to the company), and have been carried out at the company's own instrument manufactory in Copenhagen.

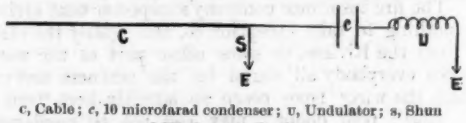
IMPROVED CUNYNGHAME MAGNETIC CUT-OUT.

MESSRS. WOODHOUSE AND RAWSON UNITED, LIMITED, are introducing a new form of magnetic cut-out in place of the well-known Cunynghame type hitherto so largely used on electric light installations in all parts of the world.

The improvements which are embodied in Bryan's patent consist in causing the current to pass round a pivoted sole-

noid, the two ends of which dip into mercury cups, this solenoid being drawn back on a fixed iron core when the current exceeds a predetermined strength. This strength may be altered by inserting more or less of the iron core

* The shunt and the capacity of the condenser must be varied according to the condition of the line, the speed of working, &c. Sometimes it is preferable to use the condenser without a shunt, for



C, Cable; c, 10 microfarad condenser; U, Undulator; S, Shunt 2,000 ohms; E, Earth.

instance, when earth currents are felt; and at the English end of the Swedish cables the arrangement sometimes preferred on high speed is as shown in the diagram.

into the solenoid; to allow of this being done the iron core may be moved in or out of the solenoid as desired.

This instrument has the advantage over the older type of requiring no insulation liable to combustion; it is mounted on slate or other incombustible material, no other insulation being necessary. The legs of the solenoid are always fully immersed in the mercury, irrespective of the current at which it is required to break circuit.

The instrument is found to have a wider range than the old form, and is generally more simple, while even more reliable than the older type, the excellence of which has been established by years of experience with the many thousands that have been sold.

The makers show at the Crystal Palace Exhibition a number of these instruments of various sizes, having ranges from 1 to 40 ampères, 30 to 100 ampères; 100 to 250 ampères; 250 to 600 ampères; and 600 to 1,000 ampères, thus forming a series of reliable current-breaking instruments for all currents, from 1 to 1,000 ampères.

All sizes of these instruments can be supplied from stock.

PROF. GEORGE FORBES ON THE DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.

A CROWDED audience assembled at the Society of Arts on Monday night to hear the opening lecture of the Cantor series delivered by Prof. George Forbes on "The Developments of Electrical Distribution."

OUR KNOWLEDGE IN 1885.

In his opening remarks, the lecturer called attention to the fact that ten years ago our knowledge of distribution of electricity from a central station was in a very primitive condition. In this direction very little work had then been done. Indeed, the very first step was wanting, for they had no knowledge of the strength of current which could be passed through a conductor without overheating it. The first thing done in working out the theory of distribution was to estimate the rise of temperature in conductors with different strengths of current.

LOW-TENSION SYSTEM.

When he lectured there in 1885, low-tension was almost the only one at their disposal, and when they came to look into the cost of laying the mains, it seemed as if they were to sink copper mines in the streets in order to solve the problem. When he then mentioned the fact that for a central station which should supply a hundred thousand lamps the conductors would have to be of the size of a man's body, it seemed as if it would be fatal to the progress in that direction. The Professor called attention to the fact that since the period mentioned not one single invention of importance had been added to facilitate low-tension distribution. The conclusion, in fact, had forced itself upon them that it was more economical to use a smaller current density than was then thought likely. In spite of the fact, however, that there were no important inventions, low-tension systems had become an established fact, and was capable of doing excellent work; more than that, it was a splendid means of distribution. Pointing out the fundamental difference between the high and low pressure distribution the lecturer said that the scope of his previous Cantor lectures was to show the means by which the amount of copper could be actually reduced. The resistance offered by conductors to electric current was of course a considerable one, the energy is absorbed and wasted by the resistance offered, and this of course seriously affected the coal consumption. To reduce the waste by increasing the size of the conductor cost more in the primary outlay, and an increased interest on the capital expenditure might swell the cost too much in this direction, and as he had shown, the diminution of the conductor engendering waste also raised the cost of production. It was then a most important function for the engineer to determine the actual size of the conductor. Large experience inclined to the fact that the most economical was not above 500 ampères per square inch, generally a less current than that. The trouble connected with the resistance of conductors was that when many lamps were in use the large current necessary to supply them was considerably reduced in being forced through the conductors and some of the lamps became dim, and the further distance the lamp was away the lower was its pressure. This difference was particularly noticeable in lamps near the station and the lamps at the utmost limit of the supply. They often found that the lamps near a central station in the busiest hours were brighter than usual, and the mostdistant ones more dim. This solution of the trouble by increasing the pressure above the normal in a central station at the busiest hours did not go far because they must allow no great variation in any lamp. The Board of Trade allowed a very large fluctuation of 8 per cent., that is, 4 per cent. above and 4 per cent. below the normal. In this respect, said Prof. Forbes, it was to be regretted that the supply companies availed themselves to the full of this latitude. This was shown by diagrams taken from supply circuits. For further improvements in the supply it was necessary to introduce feeders. With the aid of a coloured plan the feeding system was graphically placed before the audience. Continuing his address, the lecturer said he did not intend to pass further in review the general principles of low tension distribution. With a pardonable feeling of pride he mentioned the fact that he had not, after the last seven years' practical work, one word to alter in his opinion expressed in his former lecture. Although it might have been interesting and profitable to have given a description of the central stations in Europe and America, with many of which he was well acquainted, he would refer his readers to the accounts given in the technical press and other publications. It will be found that there are engineering resources at our call which have yet to be drawn upon before they had reached altogether the final solution of the problem.

CENTRAL STATION *v.* ISOLATED PLANT.

As an example, he would point out one or two facts in the economy of electric lighting which form a not uninteresting view of the present condition of affairs, and threw some light upon a point that engineers had been rather prone to overlook, and that was central station distribution as distinguished from isolated plant. Central station distribution, as distinguished from isolated plant, involved large additional expense in distributing mains. The cost of the mains bore a very large proportion in the earnings, and until consumers were more closely packed than they were at present that would remain the case. As things were at the present moment, an electric lighting company had to lay mains throughout a whole district, and yet perhaps not one house in 30 was taking current. Thee arnings in this case would be very different when a larger proportion of houses were supplied with the current. Another fact was that the machinery at present was lying idle the greater portion of the day and earning no dividend, and a third reason was that, owing to the limited period during each day that the maximum demand existed, they were wasting fuel in heating the boilers for perhaps a couple of hours' work. They were also wasting a great deal of steam by working their engines under their full economical load. The Professor was reasonable when he said that these points must be fully considered. The net result was, rightly says the lecturer, that electricity in London, for instance, costs twice as much as gas. It costs more to obtain it from a public supply than it could be manufactured for on the premises of a large establishment working long hours. He thought the present method of debiting customers was unfair to those who used the current long hours. He said they must not be led away by the too optimistic statements of those who were interested in trying to make electricity out too cheap. The electrical industry had nothing to fear from competition, and the best way to gain the confidence of the public, and making some progress, was to openly state the cost, and apply all skill to overcome the difficulties. At this point he gave one or two facts to illu-trate the truth of these remarks. One was in the lighting of streets; it was a great misfortune, he considered, that the streets of London were not supplied by arc lights. They knew from actual experience that arc lamps of 10 ampères each could be run for a year, that is, 4,000 hours, for about £30; but at 7d. per unit, the cost came to about £60, double what it would be if privately worked. That was an illustration of the present system of charging for current, and it was un-

fair, as he previously remarked, upon the consumers that had long hours. Careful comparisons of the costs of lighting of large establishments showed the difference when it is manufactured on the premises and supplied by a company. He gave here an example of the Athenæum Club, which cost at the present moment, manufacturing its own light £894, besides the depreciation of machinery, which cost £2,538. The charge if supplied by a company would come to £1,452. The lecturer here introduced the well-known arguments of the superiority of electric lighting over gas, the saving effected in house decorations, and preservation of books and pictures. These were sufficient recommendations, in his opinion, for those who value cleanliness and health. To improve their system of distribution they must keep before their minds the perfect ideal, and to depart from that only to gain unmistakable practical advantages. This was the spirit in which the dynamo had been improved until it gave an efficiency of 96 per cent., where the steam engine which had been before it for fifty years only reached 80 per cent. as a machine or motor converting indicated in available horse-power. Had it not been for the fact that scientific men took up dynamo construction they would have rested content with 50 per cent. which was reached by Brush and others in their thoroughly well-designed if uneconomical dynamos. The serious losses in those machines was owing in a great measure to their construction; the rapidly revolving parts of the armature, which as they all knew required most mechanical strength, was built up of an iron spindle, a wooden hub, an armature made of iron wire wound with copper wire, and other parts composed of millinery paper and sealing wax. Nowadays they had a fairly strong and economical armature. The same applied to electrical distribution. Ten years ago they strived for the ideal, they made elaborate calculations of the probable consumption; they tried to point out the relative size, and to determine the best points of the connection for the feeders on the distributing mains; they tried to vary the dimensions of the distribution mains; they tried to do all these things and use the least amount of copper. They calculated beforehand the probable demand that there would be on the mains at different points, and they tried to devise means of regulating the electrical pressure on the feeders so as to waste no copper, or not more than was absolutely necessary. Ten years of practice had stereotyped their practice a good deal, and while they did not lay the conducting wire by the shortest route they always had in their minds this leading principle while laying out and planning electrical mains. They readily adopted average results to simplify the system. At the date of his previous Cantor lectures the question before their minds was whether central stations were economical or not, and whether it was only advisable to have stations where it was not possible to put in isolated plant. It was obviously more convenient to be supplied from a central source, in fact a private supply would be impossible except in the case of a large establishment. The fact remained that central stations, with all their additional costs and mains running through the streets, which necessitated taking up and making good the roadways, were increasing rapidly. The legislation in 1882 on the question of granting licenses of electric lighting was conceived in the spirit that a few people might club together within an area of 100 yards from the supply of electric current from a central source. The fact had been most thoroughly established, however, that current could be economically obtained from central stations, and the proof of that lay in the enormous ramifications of the electrical circuits now occupying the streets of London. He knew of no town in the world where such enormous progress, designed for a permanency, had been made. Since Major Marindin's report of the enquiry held in 1889 was published the whole place had been put into the hands of electricians; the work had been thoroughly considered and thoroughly matured, and the consequence was that they could feel a pride in the work that had been done in the last two or three years. They must not overlook the fact that electric current from a central station is not cheap. The number of hours that each lamp was in use in a central station was a little over two hours and a greater part of the day, mains, boilers, and engines were earning no dividend. If they were supplying the electric current the greater part of twenty-four hours they would be able to reduce the price to one-third. The Professor spoke at this point of the absolute safety of the electric light as regards fire. They were also absolved from the possibility of anything equivalent to gas explosions, and great economy could be effected in a house using the electric light, by the switching off lights when not required. There was one case in which electricity was more economical than gas, in fact more economical than any other illuminant; that was in the case of a country house where there was no public supply of any kind, and where illumination must be produced on the premises. Numerous examples bore testimony to this fact; a notable one was that of a country house with which he was acquainted, where they had 210 16-C.P. lamps. Although these were running for long hours, and during the whole of the year, the whole cost including labour and coal came to £75, besides depreciation on an outlay of £1,800. Nothing approaching this could have been got from gas laid down on the premises in the same conditions and at the rates which are charged by supply companies in London, the cost would have been over £300 for the same amount of light.

DISTRIBUTION.

The satisfactory working of a central station depended on the proportion the feeders bore to the distributing mains. Many stations had been started in an ill-considered manner, and had no feeders at all; the consequence was that they had very large variations in the pressure at different times, in fact at times the difference of pressure amounted to 25 volts, and instead of applying careful regulations, an attempt had been made to get over this difficulty by putting in lamps of different voltage requiring different pressure, according to the position in the system. Where this was done they were sure to be landed in a difficulty; he had seen the plan adopted in America with disastrous results. He was desirous of giving some accurate information from a large number of central stations as to the feeders and distributing mains, and he had sent out a circular asking for figures as to the weight. He had not obtained much information, but he was able to give them one or two instances. In the Kensington and Knightsbridge Company the total weight of mains for distribution was 133 tons, the weight of the feeders 15½ tons; this covered a total length of street of 12½ miles; the mains were partly bare copper strips and partly vulcanised rubber leads. The lecturer then gave costs per yard of the laying of the mains in the two various ways. He was understood to say that the cost of the mains was as follows:—A 15-inch culvert, carrying three strips, was £1 3s. 9d. per yard; a 20-inch culvert, carrying five strips, was £1 9s. per yard; a 24-inch culvert, carrying seven, cost £1 14s. 2d. per yard. The figures relating to the pipes carrying cables were too indistinct to follow, except in the case of a yard of three pipes, when the cost was stated to be £1 8s. 8½d. The total sum expended by this company in the mains was 33 per cent. of the whole capital. Machinery and buildings, and that part of the original outlay, is about 43 per cent., and the batteries come to about 10 per cent. Chelmsford lighting was interesting as showing the small weight of copper used in the overhead system. High-tension alternating currents are used here; three-quarters of a ton of copper is used for street lighting, 1½ tons for the secondary, and one ton for the primary or private lighting; horse-power at the stations 300, total cost about £14,000. In another company, with paid up shares amounting to £77,000, the expenditure on mains was £17,000. Twenty miles of cables were laid, consisting of 20½ tons of copper for feeders and 28 tons for distributing. The actual cost for supplying Callender-Webber casing came to 6s. 6d. per yard, or, including drawing service boxes, 8s. 9d. The Allgemeine-Gesellschaft, of Berlin, used Siemens's armoured cable, costing from £2 to £4 10s. per yard. Other figures from an American company showed that the cost of laying a 3-inch pipe, with large brickwork manholes, &c., depended on the number of ducts. If there were only two ducts, the price per duct per yard would be 20s.; ten ducts, the price would be 7s. 6d. per yard each; and if there were 20, as was often the case, the price would be about 2s. 6d. a yard for each duct. It was a usual practice to place the pilot wire at the junction of the feeding and distributing mains. He suggested that if the pilot wire were placed not actually at the points of feeding, but half way between the points of feeding, that is instead of having the current to go 480 yards it will go to double that distance at

960 yards; moreover if they arranged it so that the feeding points had lamps of 104 volts and the distant points had lamps requiring 96 volts, neither of them requiring more than 4 per cent., they had been able to double the distance to which the feeder could work. If they now used the three-wire system of distribution we are able to go twice the distance they had before, 1,720 yards. This result had never been done in actual practice, because few people would approve of different voltage on a circuit. He had sanctioned such an arrangement in one case only, and that was the St. James and Pall Mall Company. But they knew in that district what their distances would actually be, and there was no difficulty in fixing the houses at slightly different voltages, but only to a slight extent.

IMPROVING DISTRIBUTION.

There were four methods of improving distribution, first by increasing the regularity of the engines; secondly, by a three wire system, a third by pilot connections between the feeder points, and varying the voltage of the lamps. This, however, could not be done safely in all cases. A fourth practice was to regulate the pressure by using accumulators. There was also another plan available, that was of putting the dynamos in parallel. After referring to the use of recording apparatus, the lecturer dwelt for a few moments on the improvements which had been effected in accumulators since 1885.

NOTES.

Electric Lighting at Bournemouth.—The General Purposes Committee of the Bournemouth Town Council have reported the receipt of 18 tenders for the scheme for lighting the pier, gardens, and public offices with electricity, and recommended that the tenders should be forwarded unopened to the expert selected to advise the Town Council. At the Council meeting last week the surveyor handed in the following list of the estimates for the electric lighting in question:—Barclay and Son, £6,302; Ronald Scott, £5,810; Mather and Platt, £5,280 and £4,690; Berry, Harrison and Co., £4,947; Goddard, Massey, Warner and Co., £4,840; Roper's Electrical Engineering Company, £4,627; Siemens Brothers and Co., £4,430; Laing, Wharton and Down, £4,310; Brush Electric Lighting Company, £4,038; Woodhouse and Rawson, £3,800; Crompton and Co., £3,340; Johnson and Phillips, £2,878; Rashleigh Phipps, and Dawson, £2,870; Paterson and Cooper, £2,617; Fowler, Lancaster and Co., £2,644 and £2,334; Manchester Edison Swan Company, £1,898; J. D. F. Andrews and Co., £1,438. We understand that these tenders have not been supplied to specification, and this doubtless accounts for the wide difference in the figures.

Church Lighting.—The electric light apparatus which has been fitted in Holy Trinity Church, Bournemouth, was used for the first time on Sunday evening. The installation was in every way successful. Another Hampshire church, All Saints at Southampton, used the electric light for the first time last Sunday.

Electro-Therapeutics in the Paris Hospitals.—At their meeting of December 29th, 1891, the Municipal Council of Paris voted a sum of 10,500 francs for keeping up electro-therapeutics in the Paris Hospitals.

Nominations to the Order of the Legion of Honour.—We extract the following names from the list that appeared in the *Journal Officiel* at the New Year:—To the rank of officer: M. Clérac, Inspecting Engineer to the Administration of Posts and Telegraphs. To the rank of Chevalier: M. Monnier, Professor at the *Ecole Centrale*. M. G. Dumont, principal inspector to the Eastern Railway Company. M. Vernes, engineer, director of the Continental Edison Company.

Proposed Telephone Service for Oban.—From the *Oban Times* we understand that the National Telephone Company are willing to establish a telephone exchange in Oban, provided they get 20 supporters, which number there should be no difficulty in obtaining, seeing what a great advantage such a service would be to hotel keepers, merchants and others in the height of the tourist season.

Electricity in a Swansea Post Office.—The Post Office authorities have decided to light the new Uplands office at Swansea with electricity, the main lead of which, by the way, is being carried from a suburban residence some little way off. This office will be the only branch one in the district which can claim the double dignity of possessing the electric light and the telegraph.

The Clothworkers Technical Scholarship.—Year after year, this valuable scholarship entitling the prizeman to five years training at the City Guilds and South Kensington Central Institution as well as to a sustentation allowance has been won by a pupil of St. Thomas Charterhouse School. The award has just been made to another pupil of the schools named E. Dixon, aged 13½ years. A "Bancroft" and another equally valuable scholarship have also been taken by pupils of this school.

Electric Railway from Chicago to St. Louis.—A telegram from Chicago to the *Financial News* states that a company has been formed with a capital of $1,000,000, for the purpose of building an electric railway from Chicago to St. Louis, the system being that of Mr. Edison.

Another Electrical Fire in Liverpool.—There was a repetition last week, though on a smaller scale, of the novelty of the electric fire which took place a few days ago in one of the supply boxes of the Liverpool Electric Supply Company. A supply box is inserted in the pavement at the corner of Dale Street and Hatton Garden, and shortly before ten o'clock a considerable volume of smoke was discovered issuing from the box. The company was at once informed of it, and a workman in the course of half an hour opened the box and cooled the overheated wires, his explanation of the occurrence, says the *Liverpool Courier*, being that the wires had "just got a little warm." The fire had not extended to either of the next supply boxes.

The Electric Light in France.—It is proposed to erect a central electric supply station in the town of Montfermeil in France.

Sunderland and the Electric Light.—A special meeting of the highways committee of the Sunderland corporation has been held to consider offers for lighting with electricity that part of the town composed in the provisional order which was obtained by the corporation in 1891. Applications had been invited by the corporation from companies prepared to take over the powers which the provisional order vested in them, and two were received, viz., from the Brush Electric Supply Company and Messrs. Andrews & Co., London. The terms of both offers were discussed, and it was ultimately agreed to submit the same to Mr. Shoolbred, who had previously been consulted by the committee with regard to the provisional order, and await his report.

Telephones in Canada.—A new telephone exchange capable of accommodating 6,000 subscribers is now approaching completion in the town of Toronto, Ont., Canada.

Extending the Telegraph.—According to the *Scottish Leader* the authorities of St. Martins-le-Grand have just completed an arrangement with the Treasury which may be expected to result in a material extension of telegraphic communication throughout the country. It has hitherto been a condition of the extension of the telegraph to country districts that a guarantee should be found for a sum amounting to about £40 annually. Under the new arrangements, says our contemporary, the amount of the guarantee will be materially reduced; and in many cases it is anticipated that it will be found possible to abolish it altogether. To the Scottish Fishery Board the change will mean a direct saving of about £1,100 a year.

The Electric Light in the East End.—The India-rubber manufactory of Messrs. Abbott, Anderson, and Abbott, of Dod Street, Limehouse, E., has recently been fitted throughout with the electric light. About 350 lamps are in use, current for which is supplied by a 30 H.P. dynamo.

Crystal Palace Electrical Exhibition.—The Siemens high tension current was tested at the Crystal Palace yesterday. Over 50,000 volts tension was obtained, 500 16-candle-power incandescents of 105 volts resistance each being lighted. All were kept brilliantly lighted in series. Some lamps burst, but the current arced over from the platinum wires without fusing them. The current brought by a brass disc on to a thick sheet of plate glass 2 feet by 2 feet square sent off great zigzag streaks of vivid lightning over its surface, continuous, and not in flashes. The results were magnificent.

Chiswick and Electric Light.—At a recent meeting of the Chiswick Local Board, it was decided to canvass the inhabitants of the parish and ascertain as to how many would adopt the electric light if it were introduced. It was stated that a company is willing to introduce the illuminant provided they could obtain a sufficient number of consumers.

Electric Railway at Stockholm.—We understand that an electric railway of about four kilometres long has recently been completed at Vermbol's wood pulp establishment in Stockholm.

Society of Arts.—Next Monday Prof. Forbes's Cantor lectures will be resumed. Lecture 2 will deal with high pressure supply, old attempts, alternate currents, transformers, feeders, sub-stations, overhead and underground conductors, generation of electricity by power obtained at a distance from (1) electricity, (2) gas, (3) compressed air, (4) water under pressure, load factor, and waste products.

In consequence of the illness of Prof. W. C. Unwin, F.R.S., the Howard lectures on "The Development and Transmission of Power from Central Stations," which he was announced to deliver on February 5th and five following Friday evenings, have been postponed.

The Electro-Harmonic Society.—Members will doubtless be glad to meet again on Friday evening next, for the interval since the last concert has been a lengthy one. The programme is of a lighter order than usual so far as the part singing is concerned, there being several items calculated to produce merriment. Professor Ayrton, F.R.S., President of the Institute Electrical Engineers, has kindly consented to take the chair, and we believe that Mr. Nikola Tesla will accompany him, so everybody ought to be at high tension on the evening in question.

Board of Trade and Electric Lighting.—The *City Press* states that at Tuesday's meeting of the Commissioners of Sewers, a letter was read relative to a communication from the Board of Trade, asking for any observations of the Commissioners on the systems by means of which electrical energy is to be supplied under the City of London Electric Lighting (Brush) Orders, 1890 and 1891, and stating that they had ascertained from Mr. Preece, the electrician, that no objections could be raised to the proposed mode of distributing electrical energy. This document was received without comment.

The Old Students' Association.—We are asked to state that the position of honorary secretary, vacant by the resignation of Mr. Reginald J. Jones, has been accepted by Mr. E. B. Vignoles, with Mr. A. E. Ruddock as assistant honorary secretary. All communications and subscriptions should in future be sent to Mr. Vignoles at 28, Lanhill Road, Elgin Avenue, W.

Electricity in Newspaper Offices.—The Swansea publishing offices of the *Welsh Industrial World* are lighted with electricity.

Personal.—Mr. Garcke has resigned the position of managing director of the Brush Electrical Engineering Company, but he retains his seat at the board of directors.

Mr. Raworth and Mr. Sellon have been appointed joint managers, and Mr. Geipel has been appointed superintending engineer of the company.

The Paris *Figaro* states that the Prince of Monaco has been chosen to succeed the late Dom Pedro as a Foreign Associate of the French Academy of Science.

Ystradyfodwg Lighting.—Electrical engineers seeking for business might with advantage bring the question of electric lighting before the Ystradyfodwg Local Board. Ystradyfodwg is a large Welsh town with a population of about 80,000, whose lighting arrangements are not of the best, and as the authorities are now spending many thousands of pounds in the improvement of the town, a fitting opportunity occurs for the introducing of a scheme for the adoption of electricity.

Installations of the Midland Railway.—The Midland Railway Company has in operation an installation for incandescent lighting at their St. Pancras Hotel. This consists of a duplicate plant, and drives some 1,200 8-C.P. lamps. At Bradford, an installation serving their new hotel there, the passenger station and goods station. This is a duplicate. The incandescent machines afford an output of some 300 ampères at 115 volts, and there are two 50-arc light machines. The Bradford Station Hotel, refreshment rooms, offices, and waiting rooms, are all lighted by means of the electric light. At Somers Town, St. Pancras, an arc light installation of 200 2,000-C.P. lights, serving the St. Pancras passenger station, St. Pancras new goods, and St. Pancras old goods depôt and yards. A temporary installation at Leeds (Hunslet), serving some 50 arc lights. A temporary installation at Birmingham (Lawley Street), serving some 50 arc lights. An installation providing for 150 1,200-C.P. lamps at the company's new goods depôt at Worcester Wharf, Birmingham. Provision is also made for lighting by incandescent machines new offices, bonding stores, &c. This installation is now near completion, and will, it is expected, come into operation with the new year. It is also understood that permanent installations of a somewhat extensive character have been arranged for, and are now in progress of completion at the company's goods stations and yards at Leeds, Birmingham, and Sheffield.

Mr. Tesla's Lecture to the Institution of Electrical Engineers.—On the occasion of Mr. Tesla's lecture on alternating currents of high potential next Wednesday, the members will meet at the Royal Institution, Albemarle Street.

Union Electric Company of Berlin.—Under the above name a new company has just been established (January 16th) in which the joint stock company, L. Loewe & Co., the firm Thyyssen & Co., of Mühlheim on the Ruhr, and the Thomson-Houston International Electric Company, of Boston, are concerned. From the last-mentioned company the new combination acquires all its patents and rights for Germany, Austria, and the north and east of Europe. The company will not establish special works, but will have its manufacturing done by Loewe & Co. The latter will extend its activity into the region of electricity, for which it is especially qualified by its experience in the production of instruments of precision. The new company will, in the first place, turn its attention to the electric transfer of power, especially for tramways and installations in mines. The Thomson-Houston Company, on whose system the new company will work, has done great things in this department. There are already 176 electric tram lines in operation with 2,640 motor cars and 3,246 kilometres on the above system, and 24 other lines are being built, especially the Bremen tram line, which will be opened in a few weeks. The same company, the technical management of which is in the hands of Elihu Thomson and Vandepoele, has excited attention by a system of mining machinery, rock borers, pumps, hoists, &c., which were shown at the Frankfort Exhibition. It has erected 110,000 arc lights and several hundred centrals for glow lights. The share capital of the new company is 1,500,000 marks, of which Loewe & Co. furnish 500,000 marks, and the two other participants, the remainder. The shares will not be placed on the market.—*Berlin Boersen Zeitung.*

The Royal Society.—The following papers were announced to be read before the Royal Society yesterday. Professor Roberts-Austen, F.R.S., "On the Melting Points of the Gold-aluminium Series of Alloys." Captain Abney, F.R.S., and Major-General Festing, F.R.S., "Colour Photometry."

The Electric Lighting of the City.—At last Tuesday's meeting of the Commissioners of Sewers, attention was called to the disgraceful state of the streets of the City during the past few days. Mr. Sayer explained that one of the principal causes was the opening up of the streets for electric lighting purposes. After discussing the subject further, it was decided to refer the whole matter to the Streets Committee.

Mansion Lighting.—Mr. J. C. White, of Overtoun, Dumbarton, is adopting the electric light for illuminating his house. At present Overtoun House, which stands amongst the Kilpatrick Hills, is lighted by gas made at a small private works. Mr. White, however, has decided to abandon gas to introduce the electric light, finding the motive power for generating it in a stream which runs past his house.

Liverpool Tramways: Cost of Electrical Haulage.—The ordinary general meeting of the shareholders of the Liverpool United Tramways and Omnibus Company was held last Saturday. In his speech the chairman stated that "They seemed to be still no nearer to a system of mechanical haulage that would supersede horses. They had had all kinds of haulage offered to them. Electricity answered well as a haulage power, but commercially the price was far more than horses. They had an offer of electrical haulage at 7d. per mile, with an additional charge of £1,600 for each car, with its electrical machinery attached. The 7d. per mile was much more, relatively, than the cost of horse haulage, exclusive of the capital outlay of £1,600 for each car; and as they had 234 cars, the total outlay would amount to £374,400. The same company offered the Glasgow Corporation the same service at 3½d. per mile, the physical difficulties of Liverpool accounting for the enormous difference."

Reading Electric Lighting.—The Reading Electric Lighting Company have proposed to a committee of the town council that thirty 1,200-C.P. lamps should be used for an area of street lighting instead of thirty-six five-feet flat flame burners. The committee report that if electric lamps of 1,200 C.P. all night be adopted the total cost of lighting the streets shown would be about doubled, whilst the illumination of the streets would be nearly ten times greater than at present. If the scheme for 1,200 C.P. lamps reduced to 16 C.P. lamps at 11 p.m. be adopted the illuminating power would be nearly ten times greater than at present before 11 p.m., and about one-third of what it is at present after 11 p.m. The borough surveyor is of opinion that it would be much more economical to maintain the lamps at 1,200 C.P. all night than to reduce them to 16 C.P. at 11 p.m. An alternative scheme has been submitted by the Electric Lighting Company for lighting the same area, the principle feature being a combination of the arc and incandescent systems of lighting. For the county ball, held last week, the Town Hall, Reading, was temporarily lighted by direction of the council by the Laing, Wharton, and Down Company, under the direction of Mr. F. F. Yeatman, the manager. Fifteen hundred candle-power incandescent lamps were fixed on brackets round the gallery, and four were hung in the centre of the room. The brilliant illumination gave great satisfaction.

The "Magnetic Girl."—We have taken the following from our American namesake:—"Judge—'Well, officer, who is this person, and what is she charged with?' Officer—'Sure, it's the "'Magnetic Girl,"' your Honor, and she's charged with electricity.'—*Puck*."

Electric Transmission of Power.—Professor S. P. Thompson thinks that with the splendid result of the Lauffen-Frankfort line to encourage electrical and hydraulic engineers, it may be expected that many schemes for further developments will now be put upon an assured basis. It will obviously be a mere question of means whether, as is proposed by the electricians of Chicago, the coming Exhibition of 1893 will witness there the transmission through wires of 1,000 horse-power taken from the Niagara Falls. Already electric transmission has supplanted rope transmission at Schaffhausen. And we are yet only at the merest beginning of this new branch of engineering development.

Electric Traction.—The half-yearly report of the North Metropolitan Tramways Company states "the arrangements entered into with the General Electric Power and Traction Company, Limited, for working the traffic on the Barking Road section by electricity are still in operation, and during the last half-year 38,631 miles have been run by electric power."

Cardiff and Electric Lighting.—At a recent meeting of the Electrical and Lighting Committee of the Cardiff Borough County Council, it was decided, before taking any steps in the matter of applying for a provisional order, to further advance the investigations of a sub-committee by inquiries of numerous provincial corporations. The matter will come on for consideration, and it is expected that something will be settled regarding the installation of the electric light.

Windmills as Electric Generators.—At a meeting of the Royal Scottish Society of Arts last Monday Professor Blyth of Andersonian University, Glasgow, read a paper on the application of wind-power to the generating of electricity.

St. Petersburg Electrical Exhibition.—An electrical exhibition was formally opened in St. Petersburg on Saturday by M. Vyshnegradsky, Minister of Finance, who was accompanied by a number of distinguished personages. The exhibition is of a varied and interesting character, displaying many different kinds of machines at work. The building was brilliantly illuminated by the electric light.

Phonographs for the Deaf.—We learn from the New York *Electrical Review* that Supt. Johnson, of the Deaf and Dumb Institute at Indianapolis, Ind., U.S.A., has recently made some interesting experiments with the phonograph and deaf mutes. He finds that the phonograph concentrates the sound at the drum of the ear in such a way that many of the pupils, otherwise deaf, are thus enabled to hear. Out of 56 boys and girls, only three girls were unable to hear anything at all, while 40 could hear music and 26 could distinguish spoken words.

The Chicago Exhibition.—A "List of Commissioners and Committees, Regulations, &c.," for the Chicago Exhibition, has just been issued by the Royal Commission at the Society of Arts, John Street, Adelphi, W.C. The members of the Royal Commission on the Electricity Committee are Sir Frederick Abel, Prof. James Dewar, Mr. J. Fletcher Moulton and Mr. W. H. Preece, whilst among other members of the committee are Prof. W. E. Ayrton, Major Cardew, Mr. R. E. B. Crompton, Profs. Wm. Crookes, G. Forbes, G. Carey Foster, John Perry and Silvanus Thompson; also Dr. John Hopkinson, Messrs. G. Kapp and W. M. Mordey, Lord Rayleigh, Sir Wm. Thomson, Major-General C. E. Webber and Mr. A. Siemens. Applications for space will not be received after the 29th of next month, and they must be made upon the forms obtainable at the offices, Society of Arts, John Street, Adelphi, W.C. The list above mentioned contains information of interest to all intending exhibitors, and copies may be obtained at the offices, as above.

Private Electric Lighting in Wales.—Margam Abbey, near Port Talbot, the residence of the late Mr. C. R. M. Talbot, has been lighted throughout by electricity. The installation, which has been made at considerable expense, is proving an effective boon, so much so, indeed, that its introduction into several other mansions in South Wales is contemplated, and in one or two cases tenders have been invited from local electrical engineers. The light at Margam Abbey is stated to be perfect in every detail, and has certainly proved its superiority to the old mode of lighting.

Electric Omnibuses.—A company has just been formed in Chicago, to be known as the Chicago Boulevard Electric 'Bus Company, to run 'buses on the boulevards, propelled by accumulators or other electrical appliances. As we learn that there is at present a movement afoot in Philadelphia and New York for the construction of boulevards on an extensive scale, we may possibly hear more of electric 'bus companies.

Electric Light Signalling.—We hear that experiments are now being made at Devonport on board the "Defiance" torpedo school ship, by the officers of the ship and the Royal Engineers, with the view of improving the present plan of signalling with the electric light.

Telephones and Telegraphs in Hungary.—The firm of B. Egger & Co., of Vienna and Budapest, have received the contract to supply telephonic and telegraphic apparatus for the Hungarian Postal Department for a period of 5 years. The works of Messrs. Egger and Co. at Budapest have recently been greatly enlarged.

The Electric Light at Verviers.—The theatre at Verviers, in France, is to be lighted throughout with the electric light. Tenders for the work are being received by M. Thirion, Rue Franchè, Verviers, until February 9th.

Telephones in Japan.—It is proposed to erect telephone exchanges in the Japanese towns of Kyoto, Osaka, and Kobe. The proposals are to be considered during the present session of the Japanese Diet. The estimated cost of the exchanges is £50,000.

Electric Tramways in Austria.—An electric tramway, to connect the towns of Mädrish-Ostran, Witkowitz, and Prziwos, in Austria, is projected.

NEW COMPANY REGISTERED.

Reading Electric Supply Company, Limited.—Capital £75,000 in £5 shares. Objects: To acquire and take over as a going concern the business now carried on by the Laing, Wharton and Down Construction Syndicate, Limited, at Reading, Berks, under the style of "The Reading Electric Light Depôt," and to carry on the business of an electric supply company in all its branches, including that of electricians, mechanical engineers, electrical contractors and suppliers of electricity. Signatories (with one share each): C. J. Wharton, 38, Parliament Street, S.W., electrical engineer; A. J. Ireland, 13, Mench Avenue, Harlesden, electrical engineer; H. Lee, 27, Garfield Road, Lavender Hill, S.W.; A. W. Jones, 87, Balfour Road, Highbury New Park, N., electrical engineer; E. E. Carpenter, Johnson Villa, Glen-eagle Road, Streatham; E. W. Piper, 37, Vernon Road, Bow, E.; S. H. Wise, 14, Silvester Road, East Dulwich, S.E. Registered without articles of association on the 22nd inst. by Henry F. Kite, 11, Queen Victoria Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Putney and Hammersmith Electric Light and Power Supply, Limited.—The annual return of this company, made up to the 4th inst., was filed on the 18th inst. The nominal capital is £1,000, divided into 900 ordinary and 100 founders' shares of £1 each. Seven founders' shares have been taken up, all of which were issued as fully paid. Registered office, Westminster Chambers, 5, Victoria Street, Westminster.

Provincial Electric Light and Power Supply, Limited.—The annual return of this company, made up to the 4th inst., was filed on the 18th inst. The nominal capital is £1,000, divided into 900 ordinary and 100 founders' shares of £1 each. Seven founders' shares have been taken up, which were issued as fully paid. Registered office, Westminster Chambers, Victoria Street, S.W.

Paddington and Bayswater Electric Light and Power Supply, Limited.—The annual return of this company, made up to the 4th inst., was filed on the 18th inst. The nominal capital is £1,000, divided into 900 ordinary and 100 founders' shares of £1 each. Seven founders' shares have been taken up, which were all issued as fully paid. Registered office, 13, Victoria Street, S.W.

Devonshire Electric Light and Power Supply, Limited.—The annual return of this company, made up to the 4th inst., was filed on the 18th inst. The nominal capital is £1,000, divided into 900 ordinary and 100 founders' shares of £1 each. 7 founders' shares have been taken up, all of which were issued as fully paid. Registered office, Westminster Chambers, 5, Victoria Street, S.W.

East Coast Electric Light and Power Supply, Limited.—The annual return of this company, made up to the 4th inst., was filed on the 18th inst. The nominal capital is £1,000, divided into 900 ordinary and 100 founders' shares of £1 each. 7 founders' shares have been taken up, all of which were issued as fully paid. Registered office, 5, Victoria Street, S.W.

Camberwell and Islington Electric Light and Power Supply, Limited.—The annual return of this company, made up to the 4th inst., was filed on the 18th inst. The nominal capital is £1,000, divided into 900 ordinary and 100 founders' shares of £1 each. 7 founders' shares have been taken up, all of which were issued as fully paid. Registered office, 5, Victoria Street, Westminster.

Elmore's Patent Copper Depositing Company, Limited.—The annual return of this company, made up to the 13th inst., was filed on the 21st inst. The nominal capital is £200,000 in £2 shares. 77,295 shares have been taken up, and upon all of these the full amount has been called, and £107,990 has been paid, and £46,600 has been considered as paid upon 23,300 shares. £7 10s. has been paid on 15 forfeited shares. Registered office, 64, Cannon Street, E.C.

Elmore's Wire Manufacturing Company, Limited.—The annual return of this company, made up to the 13th inst., was filed on the 22nd inst. The nominal capital is £300,020 divided into 150,000 ordinary and 10 founders' shares of £2 each. 66,025 ordinary and the 10 founders' shares have been taken up, upon all of which the full amount has been called, and £119,318 15s. has been paid, leaving £12,751 5s. unpaid, and £390 has been paid on 1,360 shares forfeited. Registered office, 64, Cannon Street, E.C.

BUSINESS NOTICES, &c.

Edmundson's Furnishing and Engineering Company, Limited.—It is interesting to note that Edmundson's Furnishing and Engineering Company, Limited, of Capel Street, Dublin, and Great George Street, Westminster, who have been engaged in electric lighting ever since the introduction of that light, have fitted up installations in almost every part of the three kingdoms. Amongst the noblemen and others to whom this firm has supplied installations may be mentioned the Earl of Aberdeen, the Earl of Kenmare, the Duke of Hamilton, the Duke of St. Albans, the Duchess of Montrose, two installations, one in her house at Newmarket and the other in her London house; the Marquis of Cholmondeley, the Earl of Wemyss, Viscount de Stern, Lord Brassey, two installations, one at Normanhurst Court and the other at Park Lane; Lord Egerton of Tatton, Lord Hillington, Lord Muncaster, Lord Revelstoke, two installations; Lord Saville, Lord Wantage, two installations; Lord Wimbourne, two installations; Lord Wolverton, two installations; Lord Iveagh, six installations; Sir George Cayley, Bart.; Sir Charles Murray, K.C.B.; Sir William Rose, Bart.; the Hon. T. A. Brassey, the Hon. H. Dudley Ryder. From the above list, which includes a very small proportion of the whole, some idea may be formed of the very extensive operations of this firm in the electrical department of their business. From the magnitude of the works they have carried out, the great number of places fitted up by them, and the length of time they have been engaged in this kind of work, their engineers, superintendents, and workmen have gained considerable experience. The authorities have taken this into consideration and placed in their hands the electric lighting of Dublin Castle. In the foregoing list may be noticed many familiar names such as Lord Iveagh, to whom Messrs. Edmundson have supplied no less than six installations, the Archbishop of Dublin, Thomas Talbot Power, Tedcastle & Co., &c.

Catalogues.—We have received from Messrs. J. D. F. Andrews & Co. a copy of their new trade catalogue of electrical fittings and accessories. Amongst other things, we notice prices and particulars of Andrews's concentric wires, of different qualities of vulcanised India-rubber, concentric flexible wires, and very full information, and prices are given of their concentric system, as well as the rates at which they will contract for electric light installations on this same system. We have pleasure in referring this catalogue to firms in the electrical trade generally.

We have received from Mr. A. E. Conti, of Genoa, a copy of his illustrated catalogue of electrical fittings, &c.

Tenders Wanted, Manchester.—The Gas Committee of the Corporation of Manchester are inviting tenders to supply and lay electrical culverts and conductors from their electric light station in Dickinson Street. This committee are also prepared to receive tenders for the supply of dynamos to the same electric light station. Further particulars will be found in our advertisement columns.

Tenders Wanted, Rostock.—Tenders are being invited for the supply of an electric lighting plant for the lighting of the public abattoirs at Rostock, Germany. Any tenders sent should reach the Registratur de Stadtbauamts, Krämerstrasse, 19, I Rostock, by February 3rd.

The Electric Light in Holborn.—Mr. H. Mather, electric lighting engineer of Brownlow Street, W.C., is putting in an installation of the electric light in the premises of Messrs. George Houghton and Sons, glass merchants, Holborn.

Priestman Brothers, Limited.—We have received from this company a circular relating to "successful progress of the Priestman Oil Engine" during the year.

CITY NOTES.

St. James's and Pall Mall Electric Light Company, Limited.

MR. EUSTACE J. A. BALFOUR presided at the ordinary general meeting of the company, which was held at the St. James's Restaurant on Tuesday last.

The meeting having been duly constituted, the CHAIRMAN proposed that the report be taken as read. The next business of the meeting was that the report and accounts for the year ending December 31st, 1891, as submitted by the directors, be adopted, and that a dividend as recommended be declared on February 1st.

Mr. LATIMER CLARK seconded, and

The CHAIRMAN, proceeding, said: I do not think it is very necessary to go in great detail into the working of the company during the past year, because the report is very full, and I think, on the whole, gives as much information as it is desirable should be placed in the hands of the public. The most important event, perhaps, of the year, was the raising of a hundred thousand pounds of additional capital in the form of preference shares for the completion of the northern station, the last fifty thousand pounds of which was largely oversubscribed at a premium of thirty shillings, a fact which I think shows both the shareholders and the public in general, a great confidence in the soundness of the company's business. This sum of a hundred thousand pounds will, as you are aware, be chiefly devoted and has been partly devoted to the purchase of a site for and the erection of our northern station. We expect that this station when erected will probably be the best of its kind in the world, as it will contain all the accumulated experience that we have gained in the erection of our present station, as well as what other companies have gained in similar work. The machinery, sufficient to furnish about 20,000 8 C.P. is already nearly completed for that station and will be placed in position as soon as the building is ready to receive it. It may be of interest to the shareholders to note that a large part of this machinery was running and supplying light at the Naval Exhibition, and we have, therefore, an advantage in purchasing it. It was purchased before it went there, and it has been running for this time without hitch or flaw. We take it over not as new experimental material, but as having actually been proved and found entirely satisfactory. A great feature in the systems which we are now developing is what we call the great trunk main, which is partially made, and which will connect the northern station with the existing station in Mason's Yard. It has a section of 8 square inches, and is probably the largest main ever made; it is capable of carrying a current sufficient to supply 25,000 lamps. The importance of this cannot be over estimated, because, well as the present station has worked, and as well as we expect it to work, it is impossible to suppose that it will not be necessary to carry out repairs in it, which might involve it being shut down for a short time. When the trunk main has been constructed, and when the northern station is in working order, we shall be in the position during the slack months of the year to shut down either one station or the other for any repairs that may be desirable, and to work entirely from one station, and that without alteration of the supply of light in the consumers' houses. An eminent electrician connected with electric lighting told me some months ago that he thought all new electric light stations should be built with two chimney shafts. Whether it is right or not I do not venture to say, but the system we propose to adopt combines all the advantages of his proposal, and a considerable number of others besides, in addition to being much more economical. I do not think I need add anything more on the particular subject of the working of the company during the past year, but I should like before I sit down to touch upon a matter which I regard as of very great importance, not only to this company, but to all electric light companies, and to the whole question of the electric lighting of the metropolis—I refer to the legislation under which we have obtained our provisional order, and which legislation was started in respect to electric lighting in the year 1882. The term fixed for the expiry of licence was seven years, that is to say, a licence could be terminated by a local authority or the Board of Trade in seven years. This legislation seems to have been passed under a fit of morbid terror that electric light companies were going to become enormous corporations with great powers of monopoly. A provisional order under the same Act was limited to 21 years. The result of this extraordinary Act was that everybody who had invested their money in electric lighting concerns lost it and the public was kept out of electric light for several years. London thereby became far behind any other capital in Europe in this matter, and far behind many towns and villages in America. Under the present Act we have our provisional order lasting for 42 years, but that provisional order and all provisional orders are subject to two conditions, firstly that the Board of Trade can revise rates at the end of every seven years, that is, they can step in and say to us you are charging too much at the end of every seven years tenure, beginning from 1889, and secondly, the Board of Trade has arranged to put into every parish or district or area in London at least two electric lighting companies. Now, if you will consider these points for a moment, I think you will see that they act first of all against the consumers, indirectly, also, against the electric light companies. As we have only a terminable lease of life of 42 years, it is absolutely necessary for us to put by what we have termed a redemption fund calculated to be sufficient to replace the deficit in the capital account, which we anticipate at the end of our 42 years. We shall be obliged, or may be obliged, to hand over our business at a valuation to the local authority which has the option of purchase. If our tenure were permanent we could, after paying to our shareholders a reasonable dividend, use the amount of this redemption fund in reducing the cost of the light, and in the present year I think I might form a rough calculation, that even if we paid to our present shareholders the same dividend as we propose to pay, we should have been able to reduce the light to the consumers about a penny per unit. The power of revision introduces an element of uncertainty into the business which must be injurious to all interests concerned, nor is it likely that this revision can be made to work in a practical manner. Had the Board of Trade seen fit to grant a complete monopoly in every district, that is, a company in each district, subject to some revision of rates on a previously defined sliding scale, such a system might have been found to work. But as it is, on what basis are they going to revise? Suppose we have the case in a district or parish in London of two companies, one of which has paid for the seven years a dividend of 20 per cent., and the other of which has paid during the same period a dividend of 2 per cent.; is the Board of Trade going to insist upon the reduction of the cost of electric light because one company has paid a dividend and the other has not? In that case you would find the shareholders of the company which had paid a small dividend absolutely ruined. In fact, the Board of Trade cannot get out of this; if they are hard or unfair upon one of the companies, so they will be unfair upon all consumers of the district. I might say it is quite clear that the two systems which they have adopted, what they term limited competition, and the system of revision of rates, are absolutely inconsistent. Now the result of this is, that limited competition is injurious alike to consumer and purchaser, in that it makes it necessary to earn a dividend on a much larger capital than would be necessary to supply that district. Supposing you have two electric stations and two sets of mains in one district instead of one, the amount supplied in the district is the same, but dividends have to be earned on double the capital necessary. You have in addition to that the disadvantage that the streets are twice pulled up, and we have also to consider the initial expenses of the company have to be twice gone over, and these, gentlemen, are items which are very much larger than those who are not in the middle of the business are apt to think. I do not think that I have anything more to say, but I shall be glad if shareholders have any remarks to make that they will do so.

Col. FRANCIS said he desired to make certain remarks and to ask certain questions which he considered he was entitled to have answered. He wished to question paragraph seven of the report, in which the net earnings during the past year were stated to be £10,395. He claimed that the net earnings of the company for the past year had been £15,409. He had added to the net earnings, as stated in paragraph seven, the total amount of the depreciation fund and the redemption fund. His reason was, that he found that a very large sum of £1,702 had been charged during the year to the repair of machinery. When he was a director of the company, he consulted each of the makers of the machinery, and they informed him that if the machinery were kept in perfect repair the depreciation would be very slight. He did not say that there was no depreciation, but he thought five per cent. on the total outlay of the machinery would be ample for the purpose. At any rate he asked on what calculations the enormous sum of £4,013 for depreciation had been arrived at, after the sum of £1,702 had been spent in repairs. Had the original articles of association remained in force, it would have been impossible to introduce such a charge as redemption fund. The painful impression of last year still remained in the minds of the shareholders, which was represented to them in the concluding paragraph of last year's report, that in order to get a quotation on the Stock Exchange it was necessary to remodel the articles of association. He wished to know the grounds on which the directors state that there will be loss of capital at the expiration of the term covered by the provisional order. Turning to the capital account, he found that the sum of £20,297 had been paid for the new site. They would remember that the site in Mason's Yard cost £9,500, and that a new site was obtained while he was a director for £1,100, and a £100 a year. He had had the present site valued by the most experienced surveyor in the parish of St. James's, and he placed its value at £8,000. The offices of the St. James's Company were small, they comprised, he believed, three small rooms, and yet the directors had managed to spend £717 in furniture. Who was the vendor who held the property for the new site, and what surveyor, acting on behalf of the company, arranged the price to be paid? What sum was to be paid under the contract for building the new station, and what sum should be spent in machinery? Then came the question of the 18 founders' shares, which he firmly believed were most improperly and illegally handed over to the Debenture Guarantee Corporation. He had been told that the only thing to do was to bring an action against the company, and he asked what the directors intended to do on this point?

Mr. MUIRHEAD said he did not consider the accounts were an exhibition of economy and management of the affairs of the company. Not only had they £1,700 for maintenance and renewals, but there

was the enormous amount put to depreciation of £4,000, so that in all £7,000 had been placed to the depreciation, and to what he might call the ridiculous redemption amount. He did not see the necessity for it, because, as he read the Act, it was provided, in case the business was taken up by the local authority, that the price to be paid was the fair market value at the time of purchase. The redemption fund, he pointed out, would, at compound interest, amount, in 40 years, to £95,000.

Mr. SCRAGG would like to know to whom the £1,000 put to redemption fund would ultimately belong, whether the founders would come in for a share.

The CHAIRMAN, in reply, said the depreciation was on the same scale as in similar companies.

Colonel FRANCIS said no similar companies had been in existence long enough to be a guide to them.

The CHAIRMAN then explained the scale in detail, and afterwards remarked that the legal expenses were not all incurred in 1891. The directors under the best advice had come to the conclusion that there would be a loss on capital on the expiration of the provisional order. With regard to the directors' fees, an answer had been given to that at a previous meeting. The amount paid for the site was £20,000, and the surveyor was Mr. Wilkinson, of 7, Poultry. The cost of the building of the new station would be £19,000. With regard to the 18 founders' shares, the directors had no views they had not already expressed, and it was not open to discuss the matter at that meeting. ("Oh, oh.") The founders would be entitled to a quarter of the amount of the redemption fund after everything was paid.

After some further discussion the report was agreed to.

On the motion for the re-election of Mr. Egerton Clarke, a retiring director,

Mr. Homan opposed the re-election on the ground that Mr. Clarke had sold on the Stock Exchange a founder's share to him for £355 on the morning previous to the meeting when the directors decided the distribution to be made, and that that share was only worth £270. He made an actual charge against Mr. Clarke, and he objected to the directors jobbing with shares on the Stock Exchange, and regretted Mr. Clarke was not present to defend himself. He moved that he be not re-elected.

Mr. Muirhead seconded the amendment.

The amendment was put and carried.

The Chairman then demanded a poll, which was arranged to be taken that day week.

Mr. W. H. Kirby, the other retiring director, was unanimously elected, and the auditors having been re-appointed, the proceedings came to an end.

Anglo-American Telegraph Company, Limited.

THE directors' report states that the total receipts from July 1st to December 31st, 1891, including the balance of £527 4s. 10d. brought forward from the last account, amounted to £164,121 9s. 4d. This sum, however, is subject to revision, as the law-suit between this Company and the Paris and New York Telegraph Company is still pending before the Court of Appeal. Traffic receipts show an increase of £6,157 as compared with the corresponding period of last year, but, as will be seen from the revenue account, this sum includes the adjustment of the balances to June 30th last. The total expenses of the half-year, including repair of cables, &c., as shown by the revenue account, amount to £63,507 3s. 4d. Interim dividends of 12s. 6d. per cent. on the ordinary stock, and £1 5s. per cent. on the preferred stock, were paid on October 31st last, absorbing £43,750, leaving a balance of £56,864 6s., out of which the directors recommend the proprietors to declare final dividends of 16s. per cent. on the ordinary stock, and £1 12s. per cent. on the preferred stock, amounting to £56,000, making a total distribution for the year ending December 31st, 1891, of £2 12s. 6d. per cent. on the ordinary stock, and £5 5s. per cent. on the preferred stock, leaving £894 6s. to be carried forward to the next account. The company's repairing ss. *Minia* has been engaged during the past half-year in the repair of the 1880 cable, the Brest-St.-Pierre cable, the North and South Placentia cables, and the Duxbury cable. The *Minia* has also been employed in laying a cable from North Sydney, Cape Breton, to Canso, Nova Scotia, connecting this company's system with the Western Union Company's cables between Canso and New York, thus providing an additional and alternate route, which, in the event of sudden pressure of business, or breakdown on the land lines, will be of great value. The new line completes through cable communication between England and New York City. The cost of the new cable has been charged to renewal fund. The company's cables and land lines are in good working order, with the exception of the Brest-St.-Pierre cable, which was again broken on November 18th last, at about 275 miles from Brest. It is expected that the law-suit still pending between the Anglo Company and the Paris and New York Telegraph Company, will be argued before the Appeal Court of Paris during the course of the coming month. In accordance with the articles of association, two directors of the company, Francis A. Bevan, Esq., and Charles Burt, Esq., retire at this meeting, and being eligible, offer themselves for re-election. Mr. Joshua Dean and Mr. John Gane, F.C.A., the auditors, retire, and offer themselves for re-election.

City and South London Railway Company.

THE directors' report for the half-year ending December 31st, 1891, to be submitted to the half-yearly ordinary general meeting of the company, to be held next Tuesday, states that the receipts during the half-year from all sources amounted to £20,243 15s. 4d., and the cost of working for that period to £15,516 9s. 8d., leaving a net profit of £4,727 5s. 8d. Including the amount brought forward from last half-year, the net revenue account shows a balance of £5,326 0s. 9d.; of this amount the debenture interest absorbs £4,304 10s., leaving a balance available for dividend of £1,021 10s. 9d., out of which it is recommended that the full dividend of 5 per cent. be paid on the perpetual preference shares, and although the balance remaining would allow of a very small dividend on the ordinary shares, it is recommended that it be carried forward to the next account. The number of passengers carried by the railway in the past half-year was 2,749,055, showing an increase over the previous six months of 336,712, making the aggregate number carried since the opening of the line 5,349,580. The directors have, after mature consideration, found it necessary to vary the fares at certain stations between stated hours, with a result advantageous to the company and to the comfort of the travelling public. To meet the convenience of residents along the line, a system of season tickets has been in operation since November 1st last. Notwithstanding a considerable increase in the rates and taxes and other items over which the directors have no control, they have satisfaction in reporting that the total expenditure shows a small decrease over that of the previous half-year, and it is hoped that some further reductions may still be made. The rolling stock has recently been increased by the addition of the two new locomotives referred to in the last report, which it is hoped will give greater power and speed in working the trains, and the six additional carriages have also been delivered. The fourth engine and dynamo are now in course of erection for the generating station. During the past three months the traffic of the railway has shown a marked and satisfactory increase, which there is every reason to hope will continue and be still further augmented. To meet this growing traffic, arrangements are in progress for providing a more frequent train service during the busiest hours of the day. After the experience of the past year, there is every reason to be satisfied with the use of electricity as a motive power for the working of this railway, and for a confident belief that when all the details are fully perfected, it will be found to be at once safe, convenient, and economical. The difficulties which have been experienced in dealing with the increased traffic at the King William Street station, owing to its confined dimensions and the steep incline leading to it, have induced the directors to deposit a Bill, by which they seek Parliamentary powers to make a foot subway connecting the terminus of the London, Brighton and South Coast Railway Company at London Bridge with the station already authorised to be constructed at the corner of Denman Street, and also to construct two additional tunnels under the river with easy inclines to a central station at the corner of Lombard Street, and thence under Moorgate Street to the Angel at Islington, where ample siding room can be obtained at a small cost. These proposals met with the approval of the directors of the London, Brighton and South Coast Railway, and will bring upon the line a very large and profitable traffic, and at the same time reduce considerably the cost of working the existing railway. It is also proposed to construct an inclined footway connection between this company's station and the Monument Station of the Metropolitan and the Metropolitan District Railways, and powers for that purpose are included in the Bill. The Bill will be submitted for approval at the conclusion of the half-yearly meeting. Owing to other engagements, Mr. Alexander Hubbard has resigned his seat at the board, and the vacancy thus caused has been filled by the election of Mr. Edwin Tate, of 21, Mincing Lane, London. The director retiring is Mr. Charles Grey Mott, who is eligible for re-election. The auditors retire, and are also eligible for re-election.

J. E. H. Gordon and Company, Limited.—At the annual meeting, held on Monday last, of Messrs. J. E. H. Gordon and Co., Limited, electrical engineers and contractors, of 11, Pall Mall, a dividend of 30 per cent. for 1891 was declared on the paid-up capital of £50,000, and a balance of £4,535 was carried to reserve. The following particulars regarding this company may be of interest: The company was registered on September 1890, with a capital of £50,000 in £10 shares, to acquire and carry on the business of J. E. H. Gordon, electrical engineer. An agreement of September 15th, 1890, between J. E. H. Gordon and W. J. Rivington of the one part and H. Sinclair of the other part, fixes the purchase price at £30,000 to be satisfied by the allotment of 2,000 ordinary shares of £10 each to J. E. H. Gordon, and 1,000 shares of £10 each to W. J. Rivington. The last and only return, made up to January 31st, 1891, was filed on the 28th October, 1891, 3,205 shares have been taken up, of which 3,000 were issued as fully paid. The remaining 205 have had the full amount called and £2,000 paid, leaving £50 in arrears. The shareholders are:—J. E. H. Gordon, 1, Queen's Gate Gardens, S.W., 2,000 shares; W. J. Rivington, 21, Gledhow Gardens, South Kensington, S.W., 1,200 shares; Mrs. Alice M. Gordon, 1, Queen's Gate Gardens, S.W., 1 share; Mrs. Mary E. Rivington, 21, Gledhow Gardens, South Kensington, 1 share; Mrs. Eva C. Gordon, Hornton Cottage, Campden Hill, W., 1 share; Miss Elizabeth C. Gordon, Hornton Cottage, Campden Hill, W., 1; H. Sinclair, 11, Pall Mall, S.W., 1 share; total, 3,205 shares. Registered Office: 11, Pall Mall, S.W.

Hastings Electric Light Company.—On Tuesday last, at the annual meeting of the Hastings Electric Light Company, a dividend at the rate of 7½ per cent. was declared upon the past year's working. In order to meet the increasing demand for the light, an extension of the plant has again become necessary, and it was announced that an additional issue of shares would be offered to the shareholders. A letter was read from Mr. Hammond, who is largely interested in the company, congratulating the shareholders upon their position. Messrs. H. M. Baker, jun., and G. Roddis were re-elected directors.

The Newcastle-upon-Tyne Electric Supply Company, Limited.—The annual general meeting of this company was held on Monday last at the Station Hotel, Newcastle. The report and balance-sheet were adopted, and a dividend at the rate of 4 per cent. per annum was declared for the year ending December 31st, 1891.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Jan. 21st.)	Closing Quotation. (Jan. 28th.)	Business done during week ending (Jan. 28th, 1892.) Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 — 102	99 —102	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	51 — 52	51 — 52	51 7/8	51
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	89½— 90½	89½ — 90½	90½	89⅞
2,849,510*l*	Do. do. Deferred	Stock	13¼— 13⅜	13 — 13⅛	13 5/16	13⅛
130,000*l*	Brazilian Submarine Telegraph, Limited	10	10¼— 10¾	10¼— 10⅜	10⅜	10⅛
53,200*l*	Do. do. 5 p. c. Bonds	100	102 —105	102 —105	103	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
77,978*l*	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3⅛— 3⅜	3⅛— 3⅛	3 7/16	...
69,996*l*	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛— 2⅜	2⅛— 2⅜	2 5/16	2⅛
40,000*l*	Chili Telephone, Limited, Nos. 1 to 40,000	5	3½— 4½	3½— 4½	...	...
50,000*l*	City and South London Railway, Nos. 1 to 50,000	10	2½— 3½	2½— 3½	3⅛	...
30,152*l*	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	10	6 — 6½	6 — 6½	6½	6½
$7,716,000	Commercial Cable, Capital Stock	$100	153 —157	153 —157	157	156½
224,850*l*	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	⅜— ½	⅜— ½	...	...
20,000*l*	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½— 6	5½— 6	5⅞	5⅝
16,000*l*	Cuba Telegraph, Limited	10	10 — 11	10 — 11	...	...
6,000*l*	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	...	...
12,931*l*	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼— 3⅜	3¼— 3⅜	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10⅞— 11⅛xd	11 — 11⅛	11 3/16	11 1/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅛— 14⅜xd	14⅜— 14⅝	14⅝	14⅜
70,000	Do. 6 p. c. Preference	10	15 — 15½xd	15 — 15½	15⅝	15½
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 — 109	106 —109	108¼	107¼
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15½xd	15¼— 15⅝	15 5/16	15
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	102 —105	103½	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	107 —110	107 —110	108	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	101 —104	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	101 —104	102	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —102	99 —102	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	6 — 6½	6 — 6½	6½	6
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	2⅜— 2⅝	2⅛— 2⅜	2 1/16	2⅛
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3⅜— 3⅝	3⅜— 3⅝	3⅜	3⅛
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd	2	2⅛— 2⅜	2⅛— 2⅜	2 7/16	2⅛
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅞— 10⅛	10 — 10⅛	10⅛	10
180,042	Do. do. 6 p. c. Preference	10	14⅜— 15	14⅞— 15⅛	15 1/16	14⅛
150,000	Great Northern Tel. Company of Copenhagen	10	19 — 19½	19 — 19½	19⅛	19
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	8 — 8½	8 — 8½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	20½— 21½	21½— 22	22	21
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000 ...	10	3½— 4½	3½— 4½	3⅝	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8 — 9	8 — 9	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	2⅝— 2⅞	2⅝— 2⅞	2⅞	2⅝
10,000	Do. do. fully paid	5	4⅞— 5	4¼— 5	4⅛	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	9⅛— 10	8⅛— 8⅜	9⅜	8 7/16
447,234*l*	National Telephone, Limited, Nos. 1. to 438,984	5	4⅛— 4⅜	4 — 4⅛	4 3/16	4⅛
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½— 13	12½— 13	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12 — 12½	12 — 12½	...	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	104 —107	104 —107	106	105½
250,000*l*	Do. (issued at 5 p.m., all paid)	...	54 — 57	54 — 57	...	...
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	5½— 6½	5½— 6½	6	...
220,000*l*	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16— 5/16	1/4 — 5/16	¼	...
9,000*l*	Reuter's Limited	8	7¾— 8¼	7½ — 8	7¾	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8½— 9	8½— 9	8 15/16	8¾
7,900	Do. do. do. 7 per cent. pref.	5	7 — 7½	7¼ — 7¾	7⅞	...
3,381	Submarine Cables Trust	Cert.	116 —121	116 —121	116	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3⅜— 4¼	3½— 4	4	3⅞
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43½	42⅛
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 —103	100 —103	...	...
58,000	United River Plate Telephone, Limited	5	1 — 2	1 — 2	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	80 — 90	80 — 90	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	100 —103	101 —104	103	102
30,000	West Coast of America Telegraph, Limited	10	4 — 5	4 — 5	4 7/16	4⅛
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	99 —103	99 — 103	...	...
67,007*l*	Western and Brazilian Telegraph, Limited	15	10 — 10½	10 — 10½	10⅜	9⅞
30,364*l*	Do. do. do. 5 p. c. Cum. Preferred	7½	6¼— 6⅝	6¼— 6⅝	...	...
30,364*l*	Do. do. do. 5 p. c. Deferred	7½	3¾— 4¼	3¾— 4¼	4	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	104 —107	104 —107	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 —107	104 —107	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅝— 1⅞	1⅝— 1⅞	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9¼— 9⅜	9¼— 9⅜	9⅜	9⅛
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	7½— 8½	8 — 9	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	98 —102	98 —102	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6½— 7	6⅞— 7⅛	7 1/16	6 15/16

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7⅝.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Halifax and Bermuda Cable, 4½ per cent. bonds 85—95.—House to House Company (£5 paid) 4¼—5.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), £5⅛—£6, 1st Preference Cumulative 6 per cent., £5 (fully paid), £5¼—£6.—Liverpool Electric Supply Shares of £5 (fully paid), 4⅞—5.—Do. shares of £5 (£3 paid), 2⅜—2⅝.—London Electric Supply Corporation, Ordinary (£5 paid), 1—1½.—Do. 6 per cent. Preference, 1½—2.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—⅜.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—¼.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—⅛.—Do. Debentures 103—¼.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 1⅛—1⅜.—£5 Preference (fully paid) 3½—3⅝.—Ward's Electric Car (£10 paid), 1⅜—1⅝.

† Quotations on Liverpool Stock Exchange.

BANK RATE OF DISCOUNT.—3 per cent. (January 21st, 1892).

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

ELECTROTECHNICS.* Inaugural Address of the President, Prof. W. E. AYRTON, F.R.S.

I BEG to thank you for the great honour you have done me in electing me your President for this year—a year which the need for a new complete index of this Society's journal marks out as closing the second decade of its life; a year which sees the second thousand added to our roll of members, and a year which the Electrical Exhibition at the Crystal Palace distinguishes as inaugurating the second decade of electric lighting in Great Britain.

It has gradually become the custom for your incoming President to select, as the subject of his address, some investigation that has been engaging his attention. Following this custom, I purpose to-night to discuss an experiment in which, for the last 19 years, I have taken some part—an experiment which, of all others, has been the one I have had most at heart—and that is, how best to train the young electrical engineer.

To some it may appear that I am treading on well-worn ground; but as the problem is one that is as yet by no means solved, and as it involves the preparation of the machine that is daily used alike by the dynamo constructor, the cable manufacturer, the central station engineer and the lamp maker—viz., the human machine—the problem of fashioning this tool, so that it may possess sharpness, an even temper, moral strength, and a mental grain capable of taking a high polish, is one that, in truth, deeply concerns every member, every associate, every student of this Society.

It is only 15 years ago since I wrote from Japan to my old and valued master, Dr. Hirst, then the Principal of the Royal Naval College, Greenwich, asking whether he thought that the time had come for starting in this country a course of applied physics somewhat on the lines of that given at the Imperial College of Engineering in Japan. He replied that England was not yet ripe for such an innovation—an opinion which appeared to be borne out by the fact that after the authorities at University College, London, had in 1878 actually advertised for applications for a new chair of "Technology," they decided that it would be premature to take the responsibility of creating such a Professorship.

But matters were advancing more rapidly than was imagined by collegiate bodies; for in that same year this most valuable report on technical education which I hold in my hand was issued by a committee of the Livery Companies of London, based on the opinions expressed by Sir W. (now Lord) Armstrong, Mr. G. C. T. Bartley, Colonel (now General) Donelly, Captain (now Sir Douglas) Galton, Prof. Huxley, and Mr. (now Sir H. Truman) Wood. And although it is twelve years since this book was published, I can recommend it to your notice, for it supplies most interesting reading even at the present day.

Under the guidance of three joint honorary secretaries, Mr. John Watney, Mr. Sawyer, and Mr. (now Sir Owen) Roberts, the City and Guilds of London Institute for the Advancement of Technical Education started with a name that was very long, but in a way that was very modest, to develop a "Trades School" in accordance with this report. They borrowed some rooms, but for use in the evening only, from the Middle Class Schools in Cowper Street, Finsbury, and decided to erect ultimately a chemical laboratory in that neighbourhood.

But neither the building of a physical nor even of a mechanical laboratory formed any part of the scheme for this "Local Trades School."

For at that time the teaching of the practical applications of physics to industry hardly existed, and certainly not its application to any electrical industry other than telegraphy. To make a start, however, in such teaching was most desirable, and therefore Dr. Wormell, the enlightened head master of the Cowper Street Schools, consented to give up the use of some rooms not merely during the evening, but also during the day, to enable Dr. Armstrong and myself to carry out our plan of fitting up students' laboratories with a small amount of apparatus kept permanently ready in position.

For the devotion of these rooms to the carrying out of this new experiment we must always feel grateful to Dr. Wormell, for it was necessarily accompanied by a reduction in the size of his school, and consequently by a pecuniary loss to himself.

The first laboratory course of the City and Guilds Institute was then advertised, and on January 9th, 1880, three students presented themselves—a little boy, a grey-haired lame man, and a middle-aged workman with emphatic, but hazy, notions about the electric fluid.

In order to further utilise these rooms the Institute sanctioned laboratory teaching during the day, and one of the cellars of the Cowper Street Schools was borrowed in order to fit up a gas engine, coned shafting, and a transmission dynamometer, obtained out of the funds of the Institute; an A Gramme dynamo, lent by Mr. Sennett, then one of the students; and two arc light dynamos for transmission of power experiments, lent by the Anglo-American Brush Corporation, whose cordial interest in the work of the City and Guilds Institute has been marked throughout. And, as these dynamos were used, not for electric lighting, but as laboratory instruments for educational purposes, England can claim to have been one of the first in the field of teaching electrotechnics.

Rapidly grew these electro-technical classes; soon the temporary laboratories in Cowper Street were overcrowded, especially as applied mathematics and mechanics, under Prof. Perry, were added to the subjects taught; the £3,000 which had been set aside for the building of this "Local Trades School" grew into £35,000, thanks to the combined donations of the Drapers' Company and of the Institute, and in 1881 was laid the foundation stone of the present Finsbury College.

During the many years that Prof. Perry and I were linked together, the work of either was the work of both; but now I wish to take this opportunity of acknowledging my personal debt of gratitude for the fund of suggestion which he put forth regarding the teaching of science through its practical applications—the key-note of true technical education. The value of these suggestions you will fully appreciate, for they form the basis of those characteristic and attractive lectures familiar to so many of you who have been his pupils.

As we have seen, then, the present Finsbury College grew out of the "Local Trades School," and formed no part of the original scheme of the Institute. And it was because London was really in want of practical laboratory teaching about dynamos, motors, electric lamps, and engines, and because that want was supplied in a form suitable to the comprehension and to the pockets of workmen in the basement and cellars of the Cowper Street Schools, and last, but by no means least, because one of the Executive Committee of the Institute, Mr. Robins, strenuously exerted himself to further techical education in Finsbury, that the various electrical, physical, and mechanical laboratories now in Leonard Street, Finsbury, came into existence.

But the establishment of a Central Technical Institution "for training technical teachers, and providing instruction for advanced students in applied art and science," had been recommended in all the reports sent in to the committee of the Livery Companies by the six authorities to whom I have referred. So that in the same year that the foundation stone of the Finsbury College was laid by the late Duke of Albany, that of the Central Technical Institution was laid by the Prince of Wales.

And, if you will allow me to say so, the success of the latter institution has been no less marked than that of the former, for, in spite of the rather stiff entrance examination, the number of students who attend all four of the departments at the Central Institution is more than threefold what it was five years ago. In fact, in the mechanical and electrical engineering departments there are already about as many students under instruction as class room and laboratory accommodation will admit. Hence this year will see a considerable increase in the amount of apparatus and machinery, as well as in the space devoted to dynamos and motors, in Exhibition Road.

While, on the one hand, the rapid growth of the work of the Guilds Institute is no little due to the fact that the latter end of this century has ushered in the electric age of the world; the electrical industry of our country, on the other hand, is no little indebted to the aid so generously given by our City companies to the teaching of electrotechnics. For the students who during the last 11 years have, for an almost nominal fee, worked in the electrical laboratories at Cowper Street, at the Finsbury College, and at the Central Institution, number several thousands, and nearly every electrical works, every place giving electro-technical instruction throughout this country, employs some of them.

The success which these students have thus achieved, through their own ability and exertions, is, I think, in no small measure due to the Institute having so wisely left the teaching it gave untrammelled by any outside examining body, so that it was possible for this teaching to be directed solely to the professional needs of the students, and to be modified from time to time as it seemed necessary.

My hearty thanks are indeed due to the Japanese Government and the City and Guilds Institute, my masters during the last 19 years, for having left my colleagues and myself unfettered liberty to carry on this experiment of finding out better and better ways of teaching the applications of science to industry.

And there need be no fear that with this freedom the teaching will become stereotyped, and gradually cease to deal with the living science of the factory, for, being bound by no code, we are able to vary our methods, our experiments, and our apparatus, according to the continually changing conditions of the profession. In order that the Guilds Institute should fulfil its aim, it is absolutely necessary that its teaching should keep pace with industrial progress. Now, even if it were possible for outside examiners, with fixed scholastic notions, to aid in securing this result, would not their efforts be superfluous? for are there not *you*, the employers of labour, to ultimately decide whether the human tool we fashion is, or is not, adapted to your requirements?

Leaving now the consideration of the direct work of the City and Guilds Institute, including their extended system of technological examinations, at which last year 7,322 candidates were examined in 53 different subjects at 245 different places in Great Britain and the Colonies, the indirect results that have proceeded from the initiative of this Institute are even greater. For, while 12 years ago, education in applied science in this country was a tender little infant, requiring much watching and support, combined with constant encouragement, to-day, Technical Education—with a capital T and a capital E, bear in mind—is a stalwart athlete, the strong man on the political platform, exercising the minds of county councillors, and actually regarded as of more importance than the vested interests of the publican.

Until quite recently it was the technical education of the young engineer that had to be considered; but now the problem has become a far wider one, for the education of the British workman is being vigorously pushed forward, and I think that it has become incumbent on you—the representatives of the electrical profession—to express your decided opinion as to what this education of the electrical artisan ought to be.

The technical education snowball set in motion 12 years ago by the City companies has been rolling—nay, bounding forward—so swiftly during the last year or two, that probably some of you have hardly followed it in its rapid growth, both in size and speed. £20,000 has been spent on the Polytechnic, in the Borough Road, the Charity Commissioners have already endowed this school with an income of £2,500 a year, and it is hoped that before the building is opened, this income will have been doubled. £50,000 has been already promised for the Battersea Polytechnic, the Charity Commissioners having also

* Announced for reading last night.

undertaken to provide this technical school with an income of £2,500 a year as soon as the subscription reaches £60,000; and for the establishment of a polytechnic in the City, £50,000 has been set aside out of the funds of the Charity Commissioners, as well as a yearly grant of £5,350. Finally, not to speak of polytechnics in North, South, East and West London, Mr. Quintin Hogg has himself spent £100,000 on the Regent Street Polytechnic, while the Drapers' Company have alone given £55,000 to the technical department of the People's Palace at Stepney, and endowed it with an income of £7,000 a year. And, most recently of all, the Goldsmiths' Company have put on one side nearly a quarter of a million sterling for the land, the buildings, and for an endowment of £5,000 a year in perpetuity, for their Technical and Recreative Institute recently opened at New Cross.

The following table gives an idea of the sort of sums that are being spent on polytechnic education in London, but it does not profess to give the entire amounts that have been devoted to capital expenditure and yearly maintenance, even for the six polytechnics named in the table:—

CAPITAL EXPENDITURE.		YEARLY ENDOWMENTS.	
POLYTECHNIC, BOROUGH ROAD.			
Already spent	£30,000	Charity Commissioners alone ... ... (Endowment expected to be doubled before opening.)	£2,500
BATTERSEA POLYTECHNIC.			
Already subscribed ...	£50,000	Charity Commissioners alone	£2,500
CITY POLYTECHNIC.			
Charity Commissioners alone to spend	£50,000	Charity Commissioners alone	£5,350
REGENT STREET, POLYTECHNIC.			
Spent by Mr. Quintin Hogg	£100,000	Charity Commissioners alone	£3,500
Spent by Charity Commissioners	11,750		
PEOPLE'S PALACE, MILE END ROAD.			
Given by Drapers' Company alone	£55,000	Drapers' Company alone	£7,000
Given by Charity Commissioners alone ...	6,750	Charity Commissioners alone	3,500
TECHNICAL AND RECREATIVE INSTITUTE, NEW CROSS.			
Given by Goldsmiths' Company	£70,000	Goldsmiths' Company ...	£5,000
(Representing a total expenditure of nearly £250,000.)			
Other contributions to polytechnics in London by Charity Commissioners	£6,000	Yearly endowments of CharityCommissioners to other technical institutions in London	£3,200
TOTALS FROM THE ABOVE SOURCES ALONE:			
	£379,500		£32,500

Large as are these sums, they are, however, even small compared with the amount raised by Mr. Goschen's beer and spirit tax, which it has been decided shall be used for the public benefit, and not for the benefit of the publican. The counties and county boroughs of England now receive nearly three-quarters of a million sterling per annum, of which the whole may be devoted to technical education. The majority of the counties and county boroughs propose to utilise this magnificent opportunity and devote to technical education the entire sum allocated to them, while the remainder use at least a part for this purpose. Middlesex and London, however, stand alone, and employ their whole yearly grant of £163,000 for the relief of the rates, on the plea that they consider that the City Companies are well able to look after the technical education of London.

Besides this spirit duty, 106 towns are levying rates in aid of technical education under the Technical Institution Acts of 1889 and 1891, the number of these towns having increased by 20 in the last seven months, showing how rapidly is this desire for technical education spreading throughout Great Britain.

In addition to the sums contributed for technical education by the City Companies, collegiate bodies, and private persons who have the practical education of the nation at heart, the following represent, as far as I have been able to ascertain, the amounts that it has been already decided shall be *actually* spent, *yearly*, on technical education in England alone, exclusive of Scotland, Ireland, and Wales:—

Received from the Customs and Excise duties ...	£500,000
" " rates	18,046
Given by the Charity Commissioners	20,550
	£538,596

The yearly amount that will be actually raised under the Technical Instruction Acts will be far larger than the £18,046 stated above, for this represents only the sum of the amounts raised in the very few towns who have already made returns.

Hence the total sum to be spent in England alone on so-called technical education amounts to certainly over £600,000 *per annum.*

As the teaching of electrical technology has been started, in some form or other, in nearly every important town in Great Britain, there is no occasion for me to advocate, as I did in this room ten years ago, that a student of electrical engineering should have an education in applied science; but what I desire to most strongly urge on you to-night is, that it is your bounden duty to see that some portion of the vast sum that is about to be spent on the education of the people is used to give such a training to your workmen as shall really benefit your industry. For otherwise there is a great fear that most of the money devoted to electrical teaching will either be frittered away on the natural loadstone, rubbed-amber order of instruction so dear to the hearts of the schoolmen, or on semi-popular lectures describing in a bewildering, sketchy fashion the whole vast field of electrical engineering.

The workmen you employ are of two classes. In the one class is the man who is all day long, say, stamping out iron discs for armature cores, and the boy who, say, feeds the screw-making machine with its proper meals of brass rod. For such work no technical education is necessary: the workers are mere adjuncts to the machines, to be dispensed with as the machines become more and more perfect. Hence, unless the machine-minder has the ambition and the ability to rise to some less mechanical occupation, his activity, if any be left him after a hard day's work, had probably better be spent in effort of a lighter and more recreative character than would alone be necessary to make him a higher class of artisan.

For him the polytechnic variety course of instruction is an inestimable blessing, for he can do a little type-writing, learn violin-playing and modelling in clay, attend an ambulance class, recite a poem, and devote the remainder of his leisure to the piano, botany, sanitary science, reading books and learning how to keep them.

His general interests will be roused, the human side of his nature developed, and during the evening at any rate he may forget that he is the slave of the Gramme ring or the slave of the electric lamp.

No wonder, then, that within two months of the opening of the Goldsmiths' Institute at New Cross 4,000 members were enrolled.

But your workmen of the other class must, or at any rate ought to, think. Take, for example, the man engaged in wiring houses, whose work is continually changing, and offering small problems to be solved. Here common sense—or uncommon sense, if you prefer it—is of great value, and the work, to be good, *must* be done by a man with a knowledge of principles, and not by a mere machine-minder.

Many joints—bad joints—wires laid in cement under mosaic, which cannot be replaced except at vast expense, even although the insulation has rotted away—parqueterie floor nailed to insulated wire—switchboards screwed on to damp walls—lamp-holders that only make contact when the lamps are twisted askew—high class insulated mains terminating in snake-like coils of flexible wire rubbing against metal in shop windows, under shop fronts—heavy oriental metal lamps hanging from lightly insulated cord—all this would be avoided, if the workmen had been taught to use their brains as well as their hands.

Now, do you think that the teaching necessary for this purpose is likely to be given at the ordinary English polytechnic school? In the case of the Goldsmiths' Institute the electro-technical department has been put under the charge of Messrs. Dykes and Thornton, two diploma students of the Central Institution; and the fact that these men are, in addition, both employed in Messrs. Siemens's works at Charlton leads one to hope that their teaching, at any rate, will breathe the spirit of the factory. And, therefore, if ample funds be forthcoming for keeping the apparatus at New Cross always up to date, so that the meters, the models, the dynamos—not merely now at the start, but three years hence, six years hence—are truly representative of the industry, there will be a fair prospect that the electrical department of the Goldsmiths' Institute, although but a fraction of the whole undertaking, may really benefit the electrical workmen in the East End of London.

But my colleagues and I view with considerable apprehension the way in which the present wide demand for teachers in technical schools is being supplied. Several of our own students, for example, tempted by the comparatively high remuneration that is offered, have become teachers in technical schools immediately on leaving the Central Institution. In many respects they are undoubtedly well qualified; but if they had first spent some time in works before attempting to teach technical subjects, they would have better understood the wants of the persons whom they have undertaken to instruct.

No greater mistake can be made than to think that a student who has distinguished himself at a technical college can dispense with the training of the factory, unless it be the opposite mistake of imagining that the factory training is equivalent to or even something better than, that given at a modern school of engineering.

It is the province of the manufacturer to turn out apparatus and machinery as quickly, cheaply, and as well made as is possible; it is the province of the technical teacher to prepare the human tool for subsequent grinding and polishing in the works.

And this necessity for the teacher having himself passed through the shops has especial weight when we are dealing with the technical instruction of workmen, for in such a case there are three requirements absolutely necessary—first, knowing how to teach; second, possessing a fair knowledge of scientific principles; and thirdly—and this is perhaps the most important of all—knowing exactly what it is that the particular workman ought to learn in order to help him in his particular trade.

Schoolmasters may have the first two requisites, and so may do valuable work in connection with the variety teaching at a polytechnic; but they are not in touch with the workshop, and, therefore,

no matter what may be their scholastic attainments, no matter what the extent of their experience in training the young, they are not the persons to give the real technical education to workmen.

In addition, then, to the polytechnics, we must have special schools for special industries, where workmen are taught the application of science to their special trades; and everything taught in such a school must be taught as bearing on the particular industry which the school is intended to benefit. A teacher of physics, for instance, must remember that he is not training physicists, but workmen whose use of physical principles will be bounded by their application to their special trade. For the great danger of such teachers is that, carried away with enthusiasm for their own subject, they will not subordinate it properly to the end in view, viz., helping the workman to know what will be useful to him in his work.

Indeed, as Prof. Huxley pointed out in his original report to the Livery Companies' committee, "success in any form of practical life is not an affair of mere knowledge. Even in the learned professions, knowledge *per se* is of less consequence than people are apt to suppose. . . . A system of technical education may be so arranged, as to help the scholar to use his intelligence, to acquire a fair store of elementary knowledge which shall be thorough as far as it goes, and to learn to employ his hands, while leaving him fresh, vigorous and content, and such a system will render an invaluable service to all those who come under its influence.

"But if, on the other hand, education tends to the encouragement of bookishness, if it sets the goal of youthful ambition, not in knowing, but in being able to pass an examination, especially if it fosters the delusion that brain work is, in itself, a nobler or more respectable kind of occupation than handiwork, and leads to the sacrifice of health and strength in the pursuit of mere learning, then such a system may do incalculable harm, and lead to the rapid ruin of the industries it is intended to serve."

And I venture to think that not merely at technical schools for workmen, but at technical colleges for engineers, it should be ever remembered that the main object of the training is not the cultivation of mental gymnastics, but to enable the student to acquire knowledge and habits which shall be professionally useful to him in after life.

"Useful learning usefully taught," would be no bad motto for technical institutions, seeing that those who favour the compulsory teaching of Greek are apparently willing to accept the converse as the motto for the University. For example, Mr. Butcher, in his address delivered at the end of last session at University College, Bangor, said, "We may claim it as a distinction that in the seats of academic learning, little or nothing useful is taught;" and in an article in last month's *Fortnightly Review*, congratulating Cambridge on its recent victory over the *barbarian*, Mr. Bury says quite candidly, "Greek is useless; but its uselessness is the very strongest reason for its being a compulsory subject in the University course." And he adds, in italics, "*For the true function of a university is the teaching of useless learning.*"

A few of the county councils have realised that the real teaching of the application of science to a special industry, which is what the British workmen is so much in need of, cannot be given, as well as a host of other subjects, out of limited funds. For example, Bedfordshire has decided to spend its grant of £4,343 mainly on agriculture, market gardening, the straw trade, domestic economy, and industries for women; Cambridgeshire and Cheshire devote themselves largely to the teaching of agricultural pursuits.

But other places aim at issuing vast comprehensive programmes and turning out yearly a mighty array of students, knowing, it may be, the something of everything, but who certainly will not know the everything or something. For example, the Holland division of Lincolnshire has decided, out of only £2,000 a year, to make grants for daily schools, University extension and art schools, agricultural science, domestic economy, mechanics, commercial subjects, and ambulance teaching; while Bootle, with a yearly expenditure of only the same amount, maintains classes in five commercial subjects, in sixteen science and art subjects, in cookery, wood-working tools, as well as four courses of University extension lectures.

Because a certain building in Regent Street famed for its ghost and its diving bell was years ago named "The Polytechnic," the majority of the new technical institutions which are being established in London at such vast cost are also called "Polytechnics," and will, I fear, give only an English polytechnic course. Now, such recreative education, although admirable for those who seek relief from work in the use of their minds, is not generally sufficient for those of your workmen who use their minds in their daily occupation.

It ought, then, to be thoroughly recognised that there is an entirely new problem to be solved, and that the solution of this problem, in so far as it has been worked out at the Finsbury College and at other places giving practical teaching in the evening, must, in the language of the mathematician, be regarded simply as "the singular solution," and not the general solution, of the problem of technically educating the British workman.

Let us gratefully accept the English polytechnics, for they will undoubtedly confer benefit on our country, and all credit be to those who have so generously established them. But do not let us be misled by the similarity between their generic name and that of the German "polytechnicum" into fancying that the recreative courses of the one are equivalent to the serious education given by the other.

Like Oliver Twist, let us ask for more; for, on behalf of the large number of minds already employed in the electrical industry, and on behalf of the still larger number that will in the future be so employed, it is our duty to secure that ample provision be made in this country for the practical teaching of electrotechnics on a scale comparable with that afforded in the technical high schools of Germany and the institutes of technology of the United States.

On the screen you see projected a photograph of the façade of the Technical High School at Charlottenburg (Berlin), which appears extensive and grand; and yet, as you will see from the next photograph, it was only a small portion of the whole building that you were looking at on the first photograph. This is but one of the many technical high schools in different towns of Germany, and yet *it covers an area more than five times as large as that occupied by the Central Technical Institution in Exhibition Road, London, cost four times as much to erect, and has more than four times as much spent on its yearly maintenance.*

The next photograph shows a building devoted wholly to the training of electrical engineers, being that of the Electrotechnical Institution Montefiore at Liège, which Prof. Gerard kindly took me over this last summer, and which has since been opened. When I tell you that there are rooms for small direct-current dynamos, separate rooms for large direct-current dynamos, separate rooms for alternators, and that every three students have a separate little laboratory, with the necessary measuring instruments, all to themselves, your educational mouth will water, as mine did.

We now cross the Atlantic to the Massachusetts Institute of Technology, Boston, which, as you see, consists of several distinct buildings, the centre one being that which contains the electrical laboratories. The dynamo room now seen on the screen has many small and large dynamos in it, and yet there is ample room to walk about, for this dynamo room occupies a space many times as large as that devoted to dynamos at the Central Technical Institution of London.

Prof. Cross was so good as to mention in a letter that was shown me some two years ago, that several of the devices that had been worked out for the electrical laboratories of the City and Guilds Institute had been reproduced at Massachusetts; but there is one device that Prof. Cross has succeeded in working out, and which I should be most glad to see copied by the City and Guilds Institute, and that is, having one assistant for every five students working in the physical laboratories.

Franklin Hall, presided over by Prof. Nichols, is devoted solely to the department of pure and applied physics at the Cornell University, Ithaca. You see how large this four-storied building must be, for look how small the four-wheeled waggon standing in front of it appears.

The next three photographs show some of the provisions made for teaching electrotechnics in Franklin Hall; the electrical laboratory, under Prof. Moler; and the dynamo room, under Prof. Ryan, whose analyses of alternate-current curves are well known to you all.

I might show you photographs of the electrical laboratories in Prof. Weber's new building for physics at Zurich, on which £100,000 has been already expended. In fact, my choice of magnificent Continental and American laboratories has been so great that I have hardly known which to select as specimens.

But there is one thing I cannot show you—and it must remain for the exercise of your influence as representatives of the electrical profession to make that possible—the British electro-technical laboratories for education and research which are truly worthy of London, the capital of the world.

The training of such students as those at the Central Institution must, of course, differ essentially from that of the electrical artisan, not because we or the students expect that on entering a factory at the conclusion of their college course they will start, as a rule, much above the bottom of the ladder, but because they hope in time to be able to mount higher.

They are, therefore, taught, not merely to construct meters and motors, use dynamos and engines, build a chimney and lay a street main, but, as they are not to spend all their lives wiring houses or watching a central station voltmeter, they are well practised in calculating and designing, and they further obtain sufficient acquaintance with the methods of attacking new problems not to be daunted when they meet with them in after life.

But so strong is becoming our belief in the value of science to the manufacturer, so anti-classical are some of us growing, that there is great risk that the literary side of the education of an electrical engineer will soon be wholly neglected. Now, important as it no doubt is for him to be quite at home with electrical apparatus and machinery, it is no less important, if he is to take advantage quickly of the progress made abroad, that he should be able to read a German or a French newspaper. I do not merely mean that with a grammar and dictionary, and plenty of leisure, he should be able to translate the newspaper, sentence by sentence, like a schoolboy preparing to-morrow's lesson, but that he should have the power to glance down the columns, gather the gist of the articles, and quickly see whether there be anything new that especially concerns him.

How many electricians are there in this country who can, for example, take up the *Zeitschrift für Instrumentenkunde* or the *Electrotechnische Zeitschrift*, and look through their pages as they do those of the *Electrician*, ELECTRICAL REVIEW, and the *Electrical Engineer*, during breakfast on Friday morning? There are, I know, a few—I wish I were one of them.

And yet examples are not wanting of the scientific isolation that is caused by not possessing that familiarity with foreign languages which is a characteristic of diplomatists and hotel waiters. Take, for instance, the fact that, whereas manganin was manufactured on a commercial scale in Germany, and German resistance coils have for the last three years been constructed of this material with a temperature coefficient of nearly zero, the very existence of this alloy was unknown to many English electrical instrument makers a few weeks ago; and even now many of them are still unacquainted with the composition of manganin, and its peculiar properties, as well as with the results of the extensive and striking experiments that have been carried out at the Reichsanstalt at Charlottenburg on the temperature coefficient and specific resistance of all sorts of manganin-copper-zinc-nickel-iron alloys.

This Physikalisch-Technischen Reichsanstalt, I may mention, is an establishment totally distinct from the Technical High School in

Charlottenburg, some photographs of which I showed you this evening. The Reichsanstalt is not an institution with students, but a vast series of Imperial laboratories, presided over by Prof. von Helmholtz, solely used for carrying out researches in pure and technical physics. The investigations are conducted under the direction of Dr. Loewenherz, aided by 46 assistants.

We have no establishment in Great Britain at all comparable with this Reichsanstalt. The original work turned out there in electrotechnics alone is considerable. Here are some of the published accounts of researches immediately bearing on your profession which Dr. St. Lindeck has been so kind as to send me: "Hardening Steel Magnets," "Standard Resistance Coils for Large Currents," "Tests of Commercial Ammeters and Voltmeters," "Mercury Standard of Resistance," "Photometric Investigations," "Compensation Apparatus for Ure in P.D. Measurements," "Alloys for Resistance Coils," and so on.

Surely it is part of the technical education of the electrical engineer to be taught how to read such pamphlets as these with comparative ease?

A working knowledge of French and German can be obtained without the necessity of learning to express oneself fluently in epigrammatic French, or to imitate with facility the word-building of a native German; and with such a working knowledge the average technical student may rest content. But as regards his own language he should aim at something higher, and therefore the electrical engineering students of our country should be, I would urge, practised in writing—yes, and also speaking—vigorous English.

Only the other day, Prof. Nichols, of the Cornell University, was deploring with me the rarity of finding a student of electrotechnics who could write a decent report. The experimental methods employed in the student's investigation might have been good, the mathematical analysis suitable, and the calculations exact; but the description of the apparatus and of the results obtained would be scattered pell-mell over the paper, as if the writer were quite ignorant of the fact that the style in which a dish is served up is nearly as important as the goodness of its ingredients.

Why do you suppose that Huxley's portrait has nearly as much prominence given it in the photographer's window as that of a duke or a ballet dancer? Quite as much because he knows how to express himself in terse and forcible English as on account of his wide scientific knowledge; because even when writing about dry bones the flow of his language clothes them with rounded forms.

But, you will ask, how are we to find the time for all this linguistic and literary polish? has the electrical student of to-day so many spare hours that fresh subjects of study must be sought for to fill up his leisure moments?

At present much time has to be wasted at technical and other colleges teaching students 16 years or older elementary mathematics and science, which ought to have been mastered before that age. When the education of childhood is improved, when the higher education of women is properly carried out, there will be no need for male experts to trouble about general training, for then children will spend less time at school and learn more; boys and girls will, as a matter of course, acquire the foundation of modern languages and general education; and students at a college will be able to devote their whole time to the special training—scientific, manual, linguistic, and literary—which pertains to the particular profession which their special tastes will generally have led them to select before the age of 16.

And just as methods of teaching applied science have been developed during the past few years, so I look forward to the growth of new methods of teaching what may be called applied literature. For it seems to me that there is a want of breadth in the view that because the study of Greek verse would be unprofitable for a student of electrotechnics, and because he has neither the taste nor the time to enter into the intricacies of etymology and grammar, therefore the study of modern languages and literature, even as directly applicable to his profession, should form no part of his regular training.

As well might it be thought (and I am sorry to say this view is not yet quite exploded) that because a student has neither the taste nor the time for the study of abstract mathematics, therefore he should be debarred from all work in a physical laboratory. Well, if it be generally accepted that although a young electrical engineer has no chance of becoming a Cayley or a Maxwell, still he ought to be taught such portions of mathematics and physics as will be directly useful to him in his profession, why should the certainty that he will neither become a Jebb nor a Dickens lead us to tolerate an inability on his part to speak fluently and write tersely his own language, surpassed only by his entire ignorance of every other?

Habits of scientific thought are highly necessary for electrical students; to be masters of their own language, and to know something of one or two others, are I venture to think, no less so; but the main result to be achieved, the main object to be aimed at, with every system of education, is moral thoroughness.

For until every workman, foreman, engineer, and manufacturer feels regret and pain at seeing work inefficiently performed, our national system of education will be incomplete.

All the labour now expended in watching work in progress, and in testing it when completed to see that it has not been scamped, is so much withdrawn from the real business of production. Every rise, therefore, in the standard of thoroughness of a community means the saving of waste labour. But far greater than this will be the actual increase in the productive power when each gives his best endeavours to his share of the world's work. And greatest of all will be the gain in the nation's happiness, since he who works with his whole soul knows no drudgery.

The lesson to be taught is no new one—it was set many centuries ago; and hundreds of thousands a year will be well spent if the county councils can succeed in bringing home to the hearts of us all this, "Whatsoever thy hand findeth to do, do it with thy might."

NEW PATENTS—1892.

548. "Improvements in holders for incandescent electric lamps." E. P. Allam. Dated January 11th.

568. "Improvements in electric incandescent lamps." G. Bamberg. Dated January 12th.

576. "A new or improved automatic electric heat alarm." H D. Fitzpatrick. (Communicated by the Electric Heat Alarm Company, United States.) Dated January 12th. (*Complete.*)

638. "Improvements in telephonic switching appliances." P. Rabbidge. Dated January 12th. (*Complete.*)

645. "Improvements relating to electric welding." P. Gendron. Dated January 12th. (*Complete.*)

650. "Improvements in methods of operating alternating current electro-motors, and in apparatus therefor." R. Kennedy. Dated January 13th.

772. "Electric shade holder." J. C. Swanne. Dated January 14th.

785. "Improvements in regulating sockets or fixtures for incandescent electric lamps and other translating devices, and in methods of regulating the flow of current to such lamps and other devices." E. E. Ries. [Date applied for under Patents Act, 1883, Section 103, July 6th, 1891, being date of application in the United States.] Dated January 14th. (*Complete.*)

791. "Improvements in laying and insulating electrical wires." J. B. Hamond. Dated January 14th.

798. "Improvements in electrical conductors." Siemens, Bros. and Co., Limited. (Communicated by Messrs. Siemens and Halske, Germany.) Dated January 14th. (*Complete.*)

825. "Improvements in electric cables." W. Fairweather. (Communicated by E. F. Phillips, United States.) Dated January 15th. (*Complete.*)

831. "Improvements in fixed or movable electrical switch for incandescent lamps." J. Hunter. Dated January 15th.

843. "Improvements in and connected with mounting incandescent lamps for safety purposes, particularly applicable to electric miners' safety lamps." T. Coad. Dated January 15th.

871. "Improvements in electric cables." H. H. Lake. (Communicated by D. Brooks, jun., United States.) Dated January 15th.

873. "Improvements in electric lighting, and for other like purposes." R. J. Rae. Dated January 15th.

925. "Improvements in telephonic receivers." A. Marr. Dated January 16th.

936. "An electro-mechanical device for producing corresponding positions in transmitting and receiving apparatus." S. Schuckert and A. Wacker. Dated January 16th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

17,379. "Improvements in coding and transmitting telegrams and secret messages." S. J. Mackie. Dated October 30th. 6d. Consists in coding two syllable and multi-syllable words by two letters, that taking 10 letters to the word as charged by the telegraph companies for coded messages, five words can be transmitted telegraphically by the 10 letters. 4 claims.

17,861. "Improvements in the manufacture of electrical conconductors and electrodes, and for connecting them, and for analogous purpose." J. Marx. Dated November 6th. 6d. According to the invention the heating or baking process heretofore employed in the manufacture of semi-conductors such as carbon plates for electrodes and the like is dispensed with, the carbonaceous or other equivalent materials being combined with a suitable binding agent and moulded to the required shape. 5 claims.

18,158. "An improved electric pressure indicator." C. H. Gray. Dated November 11th. 8d. This invention has for its object an improved electric pressure indicator whereby a simple and inexpensive instrument is constructed. The said instrument being so arranged that immediate warning is given to the attendants in charge of such places as gas works, &c., gas, steam, air, or other engines. So soon as the pressure becomes too high or too low in the gas mains or in the cylinders of engines or other appliances a bell or other alarum is electrically rung. 1 claim.

18,270. "Improvements in electrical conduits and conductors." J. M. M. Munro. Dated November 13th. 8d. Two or more distinct pipes or culverts are provided of insulating material which may be cement, or bitumen concrete, or cement concrete, or brickwork built with cement, but preferably fireclay pipes, or channels bedded in puddled clay or cement. One of these is to carry the positive conductors, the other the negative; the third, if there is a third, may assist either, or be partly as spare, or may in a three-wire system carry the intermediate conductors. Within each of these is laid one or a bundle of copper tubes. These may be round or slightly flattened into, say, for example, an approximately hexagonal shape so as to economise space. Each tube is first enamelled outside or coated with any preservative insulating compound, and is wound with several layers of insulating paper wound on by preference not spirally, but in wide sheets. This paper is thoroughly mixed and coated with an insulating varnish of gum, or India-rubber, or gutta-percha, or fluid bitumen or ozokerite, or paraffin, or such like insulating and waterproof substance. A spiral layer of thin cloth ribbon is then lapped on as a binding and protection. Three, five, seven, or

other number of tubes are then bound together with care to preserve the insulation, and the whole bundle is placed within the fire-clay pipe or channel and supported on insulators preferably of wood, glass, or earthenware, so that there is a clear space all round between the tubes and the channel. This space is then run in solid with bitumen, and to facilitate this, holes are left, or lids are provided of such a form that they can be securely luted up by the bitumen, or otherwise. 9 claims.

18,523. "Improvements in apparatus for heating, welding, melting, or gasifying solid bodies by electricity." H. ZERENER. Dated November 17th. 1s. 1d. Has reference to a new process and apparatus for heating, melting, or gasifying various substances by means of a voltaic arc influenced by electric currents or magnets, and entirely independent of the object to be operated upon. 2 claims.

18,556. "Improvements in electrical switches." H. J. PIERCE. Dated November 17th. 6d. The object of the invention is to cause the surfaces of switches to be held securely and closely in contact. 1 claim.

18,916. "Improvements in or appertaining to apparatus for measuring electric currents." Prof. H. ARON. Dated November 21st. 8d. The object of the present invention is to provide improved means for connecting and disconnecting an apparatus for measuring electric currents into the main circuit and out of the same without any material loss of tension, the improved means of the invention being calculated to cut the apparatus in and out of circuit, independently of the intensity or volume of current flowing through the circuit at the moment when the apparatus is being connected or disconnected. 5 claims.

19,033. "Improvements applicable to switches used for electrical purposes." WOODHOUSE AND RAWSON UNITED, LTD. (Communicated from abroad by A. W. T. Hinde, of Sydney, N.S.W.) Dated November 24th. 6d. In one arrangement of the improved type, as, for instance, in forming a double pole switch, the inventors use a single spindle and mount thereon, but insulated from the spindle, two pairs of brushes arranged by preference at points diametrically opposite each other, each pair is carefully insulated from the other, but any two brushes forming a pair are electrically connected and arranged to form arms of different radii, this being very compactly effected by fastening the longer radius one on the top of the other contact plates, to suit the brushes and springs, handles, stops, and other accessories are, of course, necessary. 3 claims.

19,034. "Improvements in electrical testing apparatus." R. J. JONES and WOODHOUSE AND RAWSON UNITED, LTD. Dated November 24th. 6d. The inventors combine with a suitable clockwork, electrical devices which shall at predetermined intervals connect to earth the middle of two lamps of equal and suitable voltage, placed in series on a circuit whose insulation they wish to test. If the insulation of the circuit is perfect, both lamps glow with equal brilliancy when electrical connection is made to earth. 3 claims.

19,049. "Improvements in electric lighting appliances for photographic and other purposes." F. L. MUIRHEAD. Dated November 24th. 6d. Consists of a parabolical or other suitable reflector made of thin metal papier maché, or other suitable material coated internally with some white pigment or the reflector may be made of white paper strained on a light framework. The reflector is fitted with a system of cords and pulleys to enable it to be raised and lowered, and also to be tilted backwards and forwards. The electric lamp used in connection with the reflector consists of two arms shaped like a pair of tongs and pivoted at the centre of the reflector at the back; the two longer branches project through the reflector and carry the carbon holders. The longer branches are of sufficient length to enable the arc of the electric lamp to be in or near the focus of the reflector. The shorter branches of the lamp project behind the reflector, and are kept apart by means of a right and left-handed screw carried by a rigid attachment to the reflector. 1 claim.

19,486. "Improvements in telephonic switching apparatus." A. R. BENNETT. Dated November 29th. 8d. The object of the invention is to improve and facilitate the working of telephonic switch-rooms when the lines connecting the subscribers to such switch-rooms are composed wholly or for the most part of metallic circuits. 6 claims.

19,650. "Improvements in the distribution of electricity through accumulator batteries." SIEMENS BROS. & CO., LTD. (communicated from abroad by Messrs. Siemens & Halske, of Berlin). Dated December 2nd. 8d. According to this invention by varying the switch connections, the supply to the distribution leads in respect of tension and quantity may be suited to the greater or less demand at different times and at different hours of the day. 3 claims.

20,100. "Improved means for controlling the supply of electric current to electric mains from a dynamo or dynamos." P. W. WILLANS. Dated December 9th. 8d. For controlling the potential at any desired point or points in electric mains used for conveying electric current from a dynamo or dynamos, the inventor leads off branch conductors from such mains at the place where it is required to maintain a constant or approximately constant difference of potential between the conductors of the main. These branch conductors he leads to the terminals of a small electric motor, located in proximity to the engine by which the supplying dynamo is driven. The small electric motor is capable of being driven in either direction. In the branch circuit he also introduces some constant source of electric current, to act in opposition to the current derived from the main conductors. A small dynamo, run at constant speed or secondary batteries, may be used for the purpose. When the current passing from the main balances the constant current, the small electric motor will remain at rest. When the current from the main varies from the constant current, the axis of the small motor will be revolved in one or other direction, according to whichever current preponderates, and may be caused to act upon the throttle valve or expansion gear of the engine by which the dynamo used for supplying current to the mains is driven, or may be caused to put a shunt resistance in or out of the circuit producing the magnetic field of the dynamo, or to alter the forces which act on the throttle valve or other gear, it may be by shifting a weight along a lever arm in connection with the valve, or in other suitable way. 1 claim.

20,321. "Improvements in the lighting of tables and the like by electricity." O. H. STOVELL. Dated December 12th. 8d. The inventor forms in the thickness of the table itself channels or passages of sufficient size to carry the insulated wire supplying the current, 3 claims.

21,116. "Improvements in electric arc lamps." A. GAY and R. HAMMOND. Dated December 27th. 8d. Has reference to improvements in lamps, in which the tendency of the carbons to be sometimes forcibly moved into contact by a shunt motor and to remain in contact for a time, due to this motor racing on first lighting up (thereby producing a large increase of current through the lamp), is prevented. To prevent the shunt motor racing, a brake is provided to retard the rotation of the shaft driven by the two motors. An arrangement for this purpose comprises a number of spring arms or blades fixed to the motor shaft, and into the path of which an arm or abutment is brought when the carbons come into contact and cause an excessive current to pass. 5 claims.

REVIEWS.

Magnetic Induction in Iron and other Metals. By J. A. EWING, F.R.S. London: The "Electrician" Printing and Publishing Company, Limited, Salisbury Court, Fleet Street.

Besides being practically the only book dealing with the subject of magnetic induction, this work considers the whole subject very exhaustively, both from theoretical and practical points of view. It is only within the last 10 years or so that the physical facts of magnetisation have got to be fairly grasped, but within this decade an immense amount of information has been gained. "After an introductory chapter, which attempts to explain the fundamental ideas and the terminology of the subject, an account is given of the methods which are usually employed to measure the magnetic qualities of metals. Examples are then quoted, showing the results of such measurements for various specimens of iron, steel, nickel, and cobalt. A chapter on magnetic hysteresis follows, and then the distinctive features of induction by very weak and by very strong magnetic forces are separately described, with further description of experimental methods, and with additional numerical results. The influence of temperature and the influence of stress are next discussed. The conception of the magnetic circuit is then explained, and some account is given of experiments which are best elucidated by making use of this essentially modern method of treatment. The book concludes with a chapter on the molecular theory of magnetic induction; and the opportunity is taken to refer to a number of miscellaneous experimental facts, on which the molecular theory has an evident bearing." The foregoing which is quoted at length from the preface of the book will give a general idea of the contents. The large number of graphic representations illustrating the various phenomena of magnetic induction are of great value, indeed, there is, perhaps, hardly any physical subject which so lends itself to graphical demonstration as that in question. Altogether we can recommend the book as being of considerable importance.

Electric Light Cables and the Distribution of Electricity. By STUART A. RUSSELL. London: Whittaker & Co., 2, White Hart Street, Paternoster Square.

Those who recollect the early days of electric lighting, will be able to call to mind the utter disregard of common principles with reference to the selection, laying down, and testing of cables, which then existed; failures were the inevitable result. Even now, however, although much experience and knowledge has been gained, a great deal of the work done is by no means entirely satisfactory, partly as a consequence of the large amount of wiring which has to be carried out in a very short time, and partly in consequence of the penny-wise and pound-foolish system of getting work done without expert supervision. Matters of this kind are, however, rapidly mending, and with satisfactory results.

The subject of electric light cables is an important one, and a treatise is well devoted to the same. Although, perhaps,

not a perfect work, Mr. Russell's book is a first-rate and very successful endeavour to deal with the whole question. Practically all points, both theoretical and practical, in connection with cables are dealt with, a free use of numerical examples in working out questions of cost and economy, being general. At the commencement a brief but interesting historical account of insulated wires is given, the use of lead-covered wires dating back to 1845, some specimens in excellent condition of which, it may be mentioned, are still extant. The various systems of main distribution, heating losses, jointing, cost of distribution, testing, safety devices, &c., are dealt with, all information which exists on the subject, either in books or journals, having been requisitioned for the purpose. As we learn as much, if not more, from failures as we do from successes, it would have been an advantage if Mr. Russell could have given some account of cases where failures of cables have occurred, pointing out to what causes these failures have been due. We must not, however, expect too much all at once, and the information which Mr. Russell has put together is otherwise so diffuse and so generally complete, that a book of very great value is the result.

CORRESPONDENCE.

Parsons Steam Turbine.

The following is a copy of a letter addressed by Principal Garnett of the Durham College of Science, Newcastle-upon-Tyne, to Professor Ewing :—

MY DEAR EWING,—My attention has been called to some questions which have been raised respecting the effect of retardation of currents phase upon the output of the steam turbine which you tested in Newcastle a few weeks ago. To determine the magnitude of the error thus caused two sets of experiments were made—the former by Mr. Parsons and Mr. Stoney, the latter by Mr. Stoney and myself. In these experiments the coils used by you were compared with the water in a section of the cooling pond. The one thousand volt armature was used, and iron pipes were thrust into the cooling pond to serve as electrodes, so that in comparison with the 1,000 volts the E.M.F. due to electrolysis was quite negligible as was also any change of phase which it could produce.

In order to secure the same number of true watts as the output of the alternator, the valve which gives the intermittent steam admission was blocked open and the steam was throttled by hand. In the second set of experiments the steam pressure at the point of admission to the cylinder was kept constant at 62 lbs., and resistance was so arranged as to keep the volts the same with the coils as with the water resistance. A variation of pressure of 1 lb. corresponds to about $1\frac{1}{2}$ units per hour in the output. The volts being the same, and the resistance of the armature practically negligible, it follows that the speed must have been the same, and the speed and steam pressure being the same, its steam consumption, and therefore the output, must have been the same, unless the steam had the intelligence to know what was going on in the external circuit, and the perversity to modify its conduct for the purpose of leading us astray. The result of this test was that with the same speed and the same steam pressure the product of Siemens and Cardew gave 49·5 for the water and 52 for the iron, showing an error of 5 per cent. due to the lag in the iron.

In the other set of experiments the volts were kept the same, but the steam pressure, as well as the ampères, were allowed to vary, two sets of observations being made upon the coils, one with a greater and the other with a less output than in the case of the water. Repeated observations of the relation between the steam pressure and the load have enabled the law of variation of the one with the other to be accurately known, and it was therefore easy to interpolate between the two observations with the coils, and to determine the apparent watts which would have been registered with the coils at the pressure used in the water experiment. The result of this interpolation showed that the product of Siemens and Cardew was 4·7 per cent. greater than the true watts.

I hope that before long it will be possible to make a test of the turbine at the full working pressure of 140 lbs., and with a boiler of sufficient capacity to give fairly dry steam at full load. It was scarcely fair to the turbine to remove its high pressure rings.

Very sincerely yours,

(Signed) **Wm. Garnett.**

To. Prof. J. A. Ewing, M.A., F.R.S., &c.
January 25th, 1892.

In reference to the letter of Messrs. Willans & Robinson in your columns of last week, we would wish to state that it was not our intention to challenge record runs, and, therefore, in the tests made by Prof. Ewing, no arrangements were made conducive to exceptionally high economies ; these are the use of very high boiler pressure and a separator, or other means for obtaining very dry steam. In the present tests the pressure at the engine never exceeded 75 lbs., and the steam was not dried.

It would be interesting to know with what steam pressure and engine Mr. Willans obtained the results stated by him at the meeting of the Institute of Civil Engineers last spring, for we are unable to find any mention of these two important factors in the proceedings of the Institute.

C. A. Parsons & Co.

Electric Organ Control.

Refering to the report published in your valuable REVIEW of the 15th inst., at page 79, on "Electric Organ Control," as a copy of a paper read by Robert Hope-Jones, before the National Society of Professional Musicians, at Leeds, December, 19th last, I beg to inform you that I have for the last five or six years been manfacturing a large number of electro-pneumatic actions for organs, on a system designed by me in 1886, which system leaves nothing to be desired, and is, I believe, the "*ideal*," as Mr. Robert Hope-Jones must have desired it for electric transmission in organ playing.

The fact that a good many electric organs have been constructed in Italy and abroad with the said system, and all giving the greatest satisfaction, is, I believe, ample proof for corroborating what I have just here before stated.

The battery power sufficient for playing a large organ on this system consists in the current furnished from eight or ten Leclanché cells of ordinary size, whose expense for cleaning and recharging, amounts to about the same number of shillings per year, or about $\frac{1}{300}$th part of the sum mentioned for working Willis's organ in Canterbury Cathedral, and about $\frac{1}{100}$th, for working the latest Lewis's electric organ.

The latest organ in construction in Italy to which my electric-pneumatic action has been applied is the large organ now being erected in the Concert Hall in the exhibition at Palermo, as constructed by Chevalier Tuzoli, of Crema. The system is quick, reliable and cheap, so much that with about £100 all the expense for the electrical material can be covered for a large organ of two manuals, having 50 and 60 stops. I send illustration of said action in fig. 2 in my latest catalogue.

A. E. Conti.

Genoa, *January 21st*, 1892.

Massage with Currents of High Frequency.

In Mr. Lawrence's letter of your issue of the 15th inst. he speaks of his experience having been gained at "*the late* Institute of Medical Electricity."

I need hardly remind your readers that the "Institute of Medical Electricity" is still very much alive—(no longer "Limited" it is true)—without the aid of Mr. Lawrence's services.

The therapeutic experiments referred to in the letter, and which are being persevered with under Dr. Harries's supervision, were conducted in "the electrified field," which is still the sole property of this Institute, and protected by patent.

J. Gale, F.G.S., F.C.S.,
General Manager.

January 23rd, 1892.

Telephonic Systems.

I have wrought out two new methods of exchange switching: "The Higgins Single-line Exchange System," and "The Higgins Metallic-line Exchange System." Believing that your readers would be interested in same, I beg to furnish you with some particulars of them, together with a new method of inter-communication between the "Williams Standard Switchboard."

Single Line Method.

In this system all indicators are dispensed with, except those of the clearing out drops, and a common call indicator for each table (this indicator is to be of not more than 10^{ω} resistance). The spring jacks used are those of the W. E. Company, and connected as on the present multiple system, only the stud of the local jack of each subscriber in the table is connected through a common indicator to ground. The stud being insulated from the other parts of the jacks, when the connection is made the subscriber is cut out of the "public wire" and placed in connection with the subscriber wanted, through the clearing out drop (special drop to fall with two rings), which, when it falls, places the subscriber again on the public wire, thus compelling the attention of the operator.

Metallic System.

In my metallic system the same principle (more or less) has been carried out. The subscriber in this case has a metallic loop. Attached to his telephone is a small key, by the pressing of which he makes (for the time being) that loop a single wire, calls the exchange in the same way as a single-line subscriber; having received his connection his wire becomes metallic as before. In this case the resistance of the indicator would not matter. In both these systems subscribers would know when they had received their connection by the fact of their being cut off the "public wire." The listening keys are in both cases dispensed with. In the single line system the test if a line is occupied or not is the same as at present, but, in the metallic system, if the click is heard, the subscriber is unoccupied; on the other hand if not heard, it is occupied.

Inter-communication between Williams's Switchboards.

Same principle again carried out on a smaller scale. Each table is supplied with a line to every other table in the switch-room, except the table on the immediate right and left of said table (which do not require them). The studs of all the cross-connecting jacks in each table are connected to a common indicator in same table. For example, say A table wants W table, she rings in jack corresponding to that letter, the operator in W table would answer call as she would a common subscriber, and give the connections. Once connected, it would be clear of call wire. This would prevent the subscriber being left disconnected after a connection. Enclosed you will find small sketches of the different articles. I beg to thank you in anticipation of your kindness in giving them your kind consideration.

Peter K. Higgins.

Chili, *November 21st*, 1891

[We have looked over Mr. Higgins's system and doubt if it would work satisfactorily. It means that from 50 to 100 subscribers would all be joined to one indicator, and before the calling subscriber could be cut off the operator would have to speak and ascertain his number, and would then disconnect him from the common indicator by putting the plug in his spring jack. Supposing the exchange could be worked in this way it would be better to do away with the drop altogether, putting the operator's telephone on direct instead. Then we should get a system of working like the Law system without the circuit wire, all disengaged subscribers' lines being on the operator's telephone. The weak point in the description seems to be in referring only to one subscriber's line. As there will be 50 all connected together provision has to be made for simultaneous calls, but how these are to be dealt with is not stated. The fall of the ring-off drop connecting the subscribers with the common wire may "compel the attention of the operator," which is a very good thing in its way, but if the operator's attention is also taken up with some of the other subscribers it means that all the subscribers are connected together. In fact, the system seems to have all the faults in working of the Law system without the advantages of the separate service wire.—EDS. ELEC. REV.]

Electrolytic Alkali.

Since the Chemical Union, so called, was formed, and particularly since the prices of the articles, soda and bleaching powder, have gone up through that combination of alkali manufacturers, we have heard of several processes for producing the above compounds—some chemical processes in the ordinary acceptation of that term, and others of an electric or electro-chemical character. Among the latter there has recently been brought to notice an electrolytic process called Greenwood's, by which it is claimed that alkali and bleach can be produced from common salt by electrical decomposition, at prices much below present rates, and the opinions of some scientific men, not chemical manufacturers, nor users of the products commercially, are given relative to certain matters connected with the electrical efficiency of the plant, or rather a portion of the plant employed, and it is rumoured that a large limited company is to be formed to purchase the patents for this process, at a large figure, of course.

Now, I would like to point out before the British public is asked to subscribe to any concern of this character, that the pioneers, or "exploiters," of the invention or inventions should first conclusively demonstrate that they can turn, and are turning, out the products they claim to be able to produce economically, commercially, in commercial quantities, and in a commercial manner.

By the process before-mentioned it is estimated that the cost of decomposing a ton of salt will be so much—never mind how much, but say from £3 to £4; but has *one ton* of salt been decomposed by the aforesaid process? and if not, what practical commercial test can we say the process has been put to? Can we say that one or more tons of caustic soda has been produced, packed in iron drums in the ordinary way, sold, and the *bonâ fide* profits on its manufacture pocketed? If we cannot say this, then, although for experimental purposes the process may be able to show a profit of large dimensions, it is not proved commercially by within many points of probability.

If a chemical manufacturer were told that by running a dynamo-electric machine for a few hours a certain chemical effect was produced upon the salt solution, which showed by chemical test a certain electro-chemical efficiency, he would not be very much startled, but would probably make the path clear by saying that he would recommend you to put down a five or ten-ton weekly plant, and run the process for a year, and see how matters worked at the end of that period.

I would say three months would be quite sufficient to prove any process on this scale, that is, running six days a week, night and day; but none of your experimental six-hour trials when on a job of this character.

Nearly a year before Greenwood's patents were even applied for, an electrical process of a somewhat similar nature was for several months worked at a large paper mill in Kent, where it was inspected by several practical paper makers; and within a month or so this process will, I believe, be undergoing such a further practical commercial demonstration as I have indicated, *i.e.*, turning out by means of electricity some ten or twenty tons a week.

Until this test is gone through, or one like it, it is simply ridiculous to attach any commercial value to an electrical salt-splitting process on the diminutive scale of Mr. Greenwood's present plant.

The work I have alluded to is being carried out at some considerable expense by the Electrolytic Caustic Soda and Chlorine Trust at their works at Snodland, on the Medway.

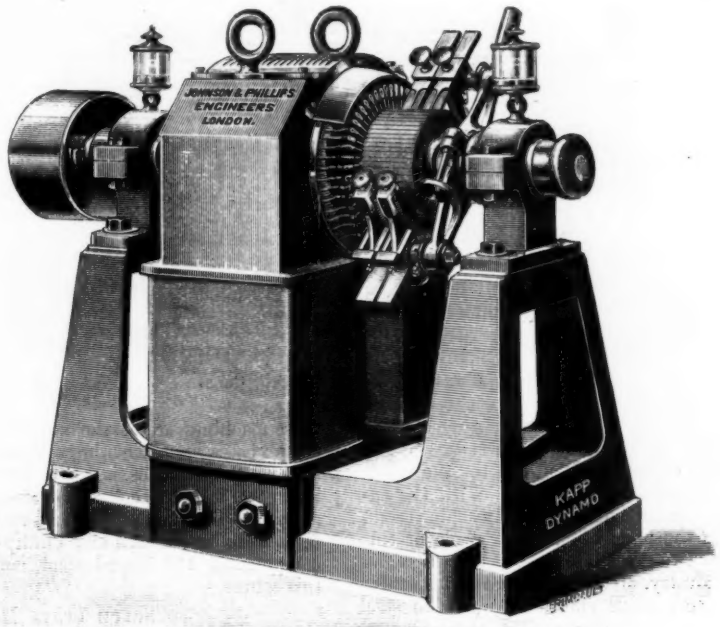
I would recommend investors to await the result of the Electrolytic Trust's operations, or work of a really commercial character, before investing in any process for the manufacture of caustic soda or bleach by electricity.

Chemical Manufacturer.

January 26th, 1892.

CRYSTAL PALACE ELECTRICAL EXHIBITION, 1892.

WHATEVER may be the merits and results of the Crystal Palace Exhibition, there can be no difference of opinion as to the high quality of the work to be seen there. This is all the more gratifying when we consider that the bulk of the machinery and engines is of English manufacture. We do not pretend to make comparison with anything that is in work in electrical design has been treated of late with scant courtesy; and although electricity has been often the guise for the sale of astounding quackeries and the perpetration of gross frauds, we know no instance of prolonged commercial prosperity built on the foundation of inferior workmanship. In this state of things large and old-



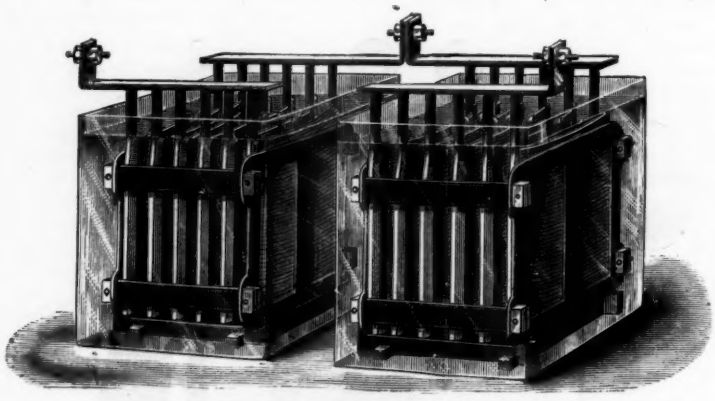
JOHNSON & PHILLIPS KAPP DYNAMO.

JOHNSON & PHILLIPS KAPP ALTERNATOR.

the Exhibition of a foreign nature, but we can rest content that our national pride for well-finished work is not likely to suffer mitigation by the collection of machinery. It would be a difficult matter to select from the *bonâ fide* electrical exhibits anything that was slipshod in design or careless in construction. In England, fortunately, cheap established firms dare not, for their credit's sake, turn out bad work, and the new men can only attain to a front place by the most superior class of goods.

We have previously pointed out that the Exhibition was in many respects likely to mark an epoch in the annals of electric lighting; in none more so will this be the case than

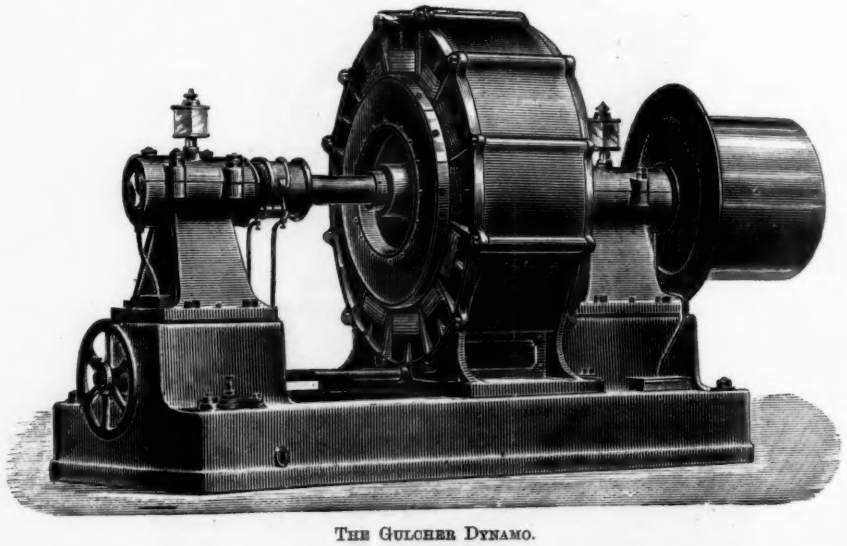
in the many forms of specially designed steam and gas engines which are collected in the machinery hall. It is a satisfactory sign to note that engine makers are paying deep and earnest attention to the needs of the dynamo. While we must of necessity leave the matter of the gas engines for another chapter, we cannot refrain from pointing out that no less than fourteen different makes of gas engines are shown. That the requirements of electric lighting have been primarily responsible for this activity is a fact which is not to be gainsaid.



JOHNSON & PHILLIPS'S D.P. CELL.

An Exhibit of Kapp Dynamos.

We have not hitherto drawn attention to the space occupied by Messrs. Johnson and Phillips. With the exception of the large multipolar dynamo in the machine room, the two stands in the south nave form the whole of this firm's collection. The two great branches, electric lighting and the cable laying industry, are separated, and pausing for a moment to note some curious effects of water on steel buoys shown in the latter collection, we will pass on to consider the electric lighting machinery. Here we find perhaps a dozen or more Kapp dynamos of various sizes, and although the biggest is not remarkable for its output, there can be no reproach on the score of size when one considers the 130 k.w. machine. These dynamos form a most striking feature, and were it only on account of their neat nickel fittings, would attract notice. The one claiming our prior attention is a small alternator of 15 kilowatts, which at 900 revolutions per minute and a periodicity of 75, gives 7½ ampères at 2,000 volts. We take this opportunity of giving an illustration of this special machine. Next comes an 18-kilowatt direct current machine, which at 145 volts has 125 ampères. We were informed that this dynamo will be used for driving the alternator during the exhibition. A 5 k.w. ring dynamo is shown which is intended to be driven by a gas engine. The machine is capable of doing 38 ampères at 130 volts. A small four-pole direct current dynamo, and a small ring dynamo are next seen. Two 8-kilowatt dynamos are coupled together in two instances, and are designed to act as regulators. There are several other machines near which possess no special features requiring notice. It is worth while to remark that the whole of these dynamos will be running simultaneously at some period of the day. All these machines are of the newest types, and present in one or two cases important improvements. The general appearance of the dynamos is much enhanced by picking out the iron parts in a dull colour and using nickel fittings. Several armatures of different types are shown. The well-known D.P. cells made by Johnson and Phillips are prominent ; a design composed of 150 incandescent lamps deriving current from this source.



THE GULCHER DYNAMO.

Seven Years' Record.

Close by the last-named stand is the exhibit of the Gülcher Company. This company is the newly organised concern of the old Gülcher Company, one of the oldest electric light businesses in England. The fact that it existed in the early days of electric lighting is eloquent of the vicissitudes through which the company has passed. It seemed at one time as if the burden would be too heavy, but careful handling brought the barque safe through the shoals. Doubtless the prosperous era which has just dawned will bring with it a share of the good things for this old concern. For years past the work of lighting the principal London exhibitions has been carried out by this company, and an installation has run successfully at the Crystal Palace for the past seven years. The stand when com-

plete will contain dynamos in parts, several dynamos of the Midget and Battersea type, arc lamps, switches, &c. The plant used for lighting the Palace consists of two 40-unit dynamos, each giving an output of 600 ampères at 70 volts shunt wound working in parallel; one 30-unit Battersea (Fricker) alternator; 90 2,000-C.P. arc lamps in centre transept: eight new Battersea (Fricker) differential arc lamps; 288 16-C.P. lamps in Picture Gallery.

The 40-unit dynamos are running the whole of the arc lamps with the exception of the eight Fricker differential lamps. The 90 arc lamps have been used for lighting the Palace for the last seven years, they were formerly supplied by four No. 5 dynamos each giving 20 units, but these are now replaced by 12 40-unit dynamos as mentioned above. The Fricker alternator is running the lights in the theatre. A Galloway engine is employed to drive the dynamos.

The Arcas Silver Plating Process.

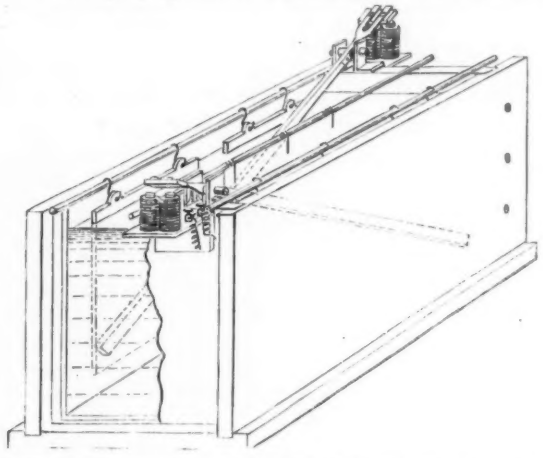
The London Metallurgical Company show at the exhibition stand articles plated by the Arcas process. Perhaps a few words on the subject of this particular form of electro-deposition may not be out of place in our exhibition articles. We believe that little has been hitherto published regarding the deposition of silver, and certainly no account has been given concerning Arcas plating. Commercially the process has been known but few weeks, although Mr. Cowper-Coles has been experimenting on behalf of the company for the past 12 months. When we say commercially we mean to say that the company has only just commenced to plate articles for the trade.

There have been many attempts to deposit an alloy of silver but they have met with little or no success. Messrs. Round and Son, of Birmingham, went further than any other experimenters when they made a plating of silver and tin, but apparently the process proved unremunerative for nothing is now heard of it.

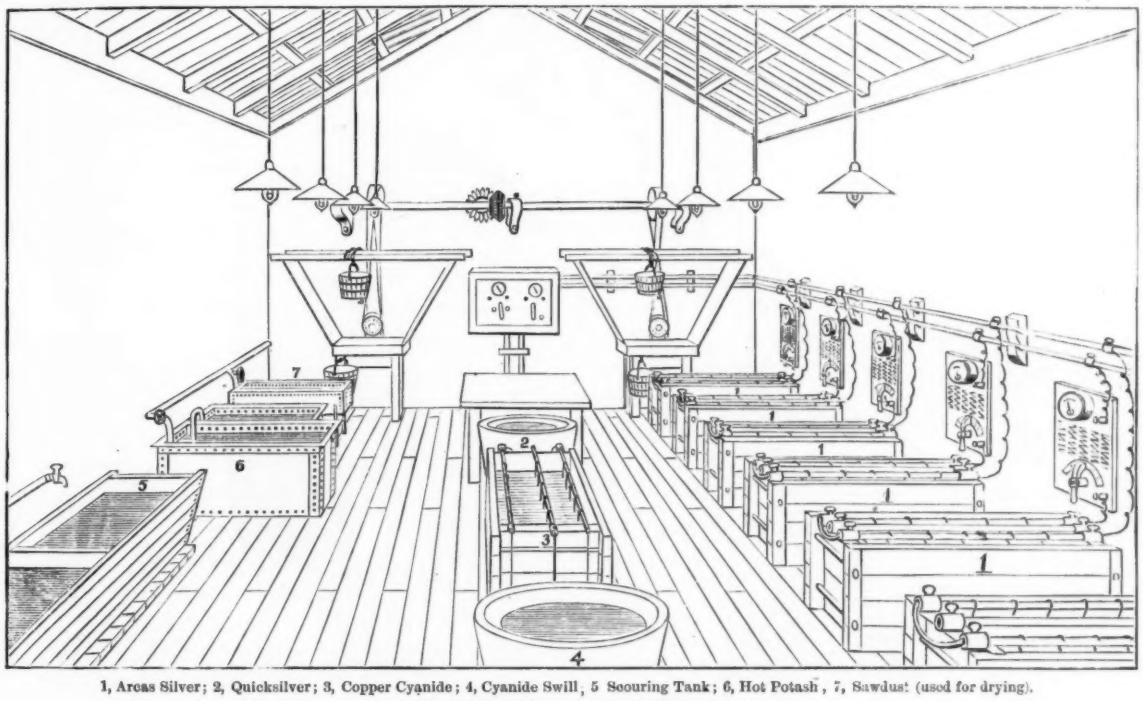
The process of "Arcas" silver plating is somewhat similar to the method adopted by most electro-platers. The secret of the system lies in the alloy used in the solution or electrolyte, but of this we hope to be able to say something further in a few weeks.

The articles to be "Arcas" silvered, when copper or brass, are first prepared in the usual way by polishing, and all grease removed by boiling in alkali, then filmed with a coating of mercury by passing them through a solution of double cyanide of mercury and potassium. They are then put into a striking bath, where a comparatively strong electric current is used, and the articles are instantly coated on immersion; they are then removed and thoroughly scratch brushed and put into the Arcas plating bath, where they are allowed to remain for some hours, according to the thickness of the deposit required. 15 ampères of current flows into this bath at a little over one volt. The articles themselves and the anodes are kept in movement during the day by means of a mechanical rocking frame, but at night an electrical agitator kept in motion by a set of E.P.S. accumulators is used, as shown in the accompanying sketch. Iron and steel articles are first of all coated with a thin covering of copper in a cyanide of copper bath, they are then put into the Arcas striking bath. Arcas plating is stated to form a good protection to iron and steel, as it is not too hard to be burnished, and is therefore far less porous than nickel. The anode used in the bath is cast from the Arcas alloy. It might be here mentioned that the whole of the work, except the rolling of the Arcas plates, is carried out on the premises. Articles requiring to be coated are first weighed, and as accurate entries are made when the Arcas alloy is given out, it is easy to check any waste that may occur. A Paterson & Cooper dynamo is used for the depositing, but this is about to be abandoned in favour of another form of dynamo. The charging of the accumulator is carried out by an Elwell-Parker dynamo.

We might add that the company are depositing platinum,



ARCAS SILVER PLATING PLANT SHOWING ELECTRICAL ROCKER.



1, Arcas Silver; 2, Quicksilver; 3, Copper Cyanide; 4, Cyanide Swill; 5 Scouring Tank; 6, Hot Potash; 7, Sawdust (used for drying).

THE ARCAS SILVER-PLATING PLANT.

irridium, and other metals, and we hope to be able to give further information on the subject of deposition carried out by this company.

An Electric Light Engine.

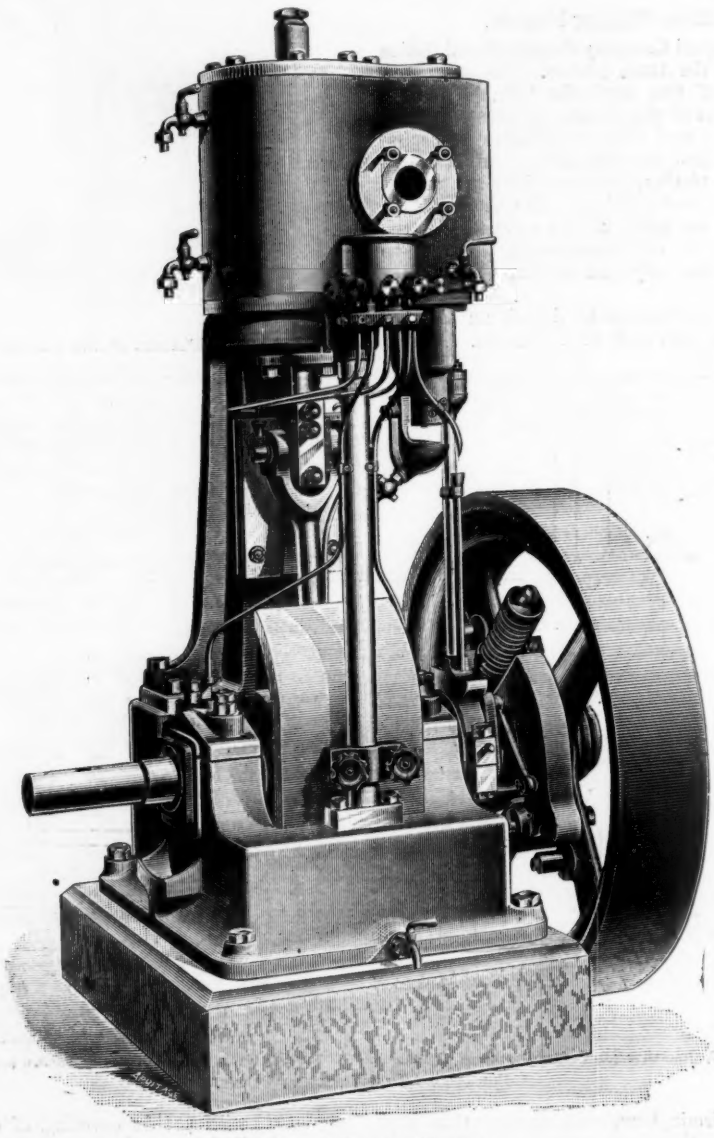
The engine which we describe here is "Class K, automatic" (open type), fitted with improved shaft governor, constructed by Messrs. Browett, Lindley & Company, Limited, Manchester. It is an engine of the very highest class and best finish, constructed particularly for electric lighting, for which purpose a large number has been supplied to many of the leading firms. This engine is fitted with "automatic" variable expansion obtained by the use of a greatly improved form of the now popular "shaft" governor which varies the throw of the eccentric direct, and, therefore, the cut-off and compression of steam.

The makers were one of the first firms in England to adopt and make this type of governor, before the present demand arose for accurately governed electric light engines, and the many years' experience thus gained has enabled them to construct a governor of this type in a manner to insure the very best results by eliminating minor defects.

As shown in the woodcut, the mechanism, which is very simple, compact and strong, is contained in the flywheel, leaving the other end of the shaft quite free, either for fixing another pulley or for coupling direct to a dynamo shaft, but the engines are made both right and left hand (the woodcut shows a right hand engine), so that a dynamo can lie on the side required.

The lubricating devices are more perfect than any other system, the necessary quantity of oil being distributed to each working part, and the drops being visible at each end of the pipes. The supply to each pipe being separately controlled while all are fed from a fixed reservoir, and when an engine is not running the whole supply of oil can be shut off to prevent waste. Steel is used throughout for forgings, and all pins are properly hardened and ground up true.

All wearing joints are adjustable for wear, and, in short, all points suggested by a long experience in this class of work are provided for by the very best mechanical arrangements and devices.



BROWETT & LINDLEY ENGINE.

Though primarily constructed for electric lighting, these engines are most suitable for driving fans, centrifugal pumps, and all other classes of machinery. Being accurately balanced they run perfectly smooth and silent. They are made in nine sizes varying from 8 to 50 I.H.P. running at speeds varying from 350 revs. in the smallest to 210 in the largest, though their speeds can be increased considerably to meet special requirements.

THE wire screen of the Edison and Swan Company, which is decorated with tinted glow lamps, is nearing completion and will shortly be lighted.